Some Systemic Effects of the Spread of Nuclear Weapons Technology: A Study through Simulation of a Multi-Nuclear Future
Author(s): Richard A. Brody
Source: *The Journal of Conflict Resolution*, Vol. 7, No. 4 (Dec., 1963), pp. 663-753
Published by: Sage Publications, Inc.
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Some systemic effects of the spread of nuclear weapons technology: a study through simulation of a multi-nuclear future

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Acknowledgments

The research reported in this study was team research and interdisciplinary research in the fullest sense of these new traditions. The director of the project—Professor Harold Guetzkow—holds professorships in psychology and sociology, as well as political science. Michael Driver and George Wright, who figured so significantly in this project, are psychologists. The simulation staff, without whom the summer 1960 running of INS-8 never would have been accomplished, were graduate students in political science, history, English, and journalism. The author of this report is a political scientist.

The future referred to in this study may never come to pass—nuclear capability may or may not spread beyond the countries now in possession of this capability. It was not the focus of this study to ascertain the likelihood of spread taking place—the study *is* focused on a "What if . . ." question and, thus, does not hold problematical the likelihood of nuclear diffusion. To support such a project, an agency of the government must have respect for basic research; the Air Force Office of Scientific Research, by its support of this research, has evidenced this respect. The author is grateful to the Air Force and Drs. Charles Hutchinson and Herman Sander for the instrumental role they played in the funding of this study. Funds for this work came from Contract AF 49(638)-72 and Research grant AF-AFOSR 95-63, Air Force Office of Scientific Research, Office of Aerospace Research.

Dr. Thomas Milburn, Head, Behavioral Sciences Group, United States Naval Ordnance Test Station, aided materially in the preparation of this report by generously allowing the author to devote part of his time at NOTS to the completion of the study.

Thanks are due to the faculty and staff of the Program of Graduate Research and Training in International Relations, Northwestern University, especially to Professors Harold Guetzkow, Richard C. Snyder, and Chadwick F. Alger, and to Dr. Robert C. Noel and Mrs. Elaine Pancoast.

Besides Michael Driver, several individuals were instrumental in the execution of these experiments (Phillip Beach, Donald Skinner, and Steven Star); I am grateful to them as I am to the fifteen other research assistants who worked through the long, hot summer of 1960.

Finally, I wish to thank the 357 students who participated in these experiments; it is to them that this study is dedicated in the hope that the world of their future may see less conflict than the futuristic worlds of their past.

Summary—preface

The effectiveness of future deterrence systems depends in part on the future state of affairs. One uncertain aspect of the future environment of a deterrence system is the nature of international affairs in a world of many rather than few nuclear powers: the so-called "*n*-country problem." It is widely asserted that an increase in the number (*n*) of nations with nuclear and thermonuclear weapons capability will produce adverse effects on the stability of the present international political system. The predicted effects usually include an increased likelihood of war; an increased difficulty of obtaining arms control or disarmament agreements; an increased probability of upsetting the "balance of terror"; and a shift in the Alliance structure. This study represents an attempt to gain insight into this possible future state of affairs by means of the controlled manipulation of an experimental "political game," the Northwestern Inter-Nation Simulation.

Scope and method

The approach in this study follows from the positing of a theoretical model of the "cold war" interaction system, the prediction of changes in this system which flow from the diffusion of nuclear weapons capability, and the exploration of the theoretical model in a laboratory simulation tailored to the study of these phenomena (Fig. 2.1).

The cold-war system is postulated as being composed of two hierarchically organized bloc-alliances with the leading nation in the bloc possessing a virtual monopoly of nuclear strike and counterstrike capability. Moreover, there is tension-generating hostility between the blocs, which reinforces cohesion within the blocs and which is itself reinforced by this cohesion. The relationship within the blocs is one of dependency, born of necessity, on the nuclear member. In part the dependency relationship is due to the hostility of the nuclear-armed leader of the opposing bloc and in part to the nuclear disparity within the alliance. It was in the context of this theoretical model that the effects of the spread of nuclear weapons were essayed and explored.

The expected change in the cold-war system is the fragmentation of the blocs which comprise it. This change will be prompted by the increased independence of the formerly nonnuclear national actors after they achieve nuclear capability. The increased sense of independence and a lowering of the perceived threat from the opposing bloc will reduce intrabloc cohesion and eventuate in the predicted fragmentation.

Minor changes in the basic inter-nation simulation were made in order to admit the study of these hypotheses. Seventeen "system runs" were accomplished, using students as decision-makers. Each of the 17 runs began at the same starting point. The experimental variable (that is, the number of nuclear powers) was manipulated in the same controlled manner for all 17 replications. Attitude scales, and communication content and flow were used to operationalize the key concepts of the theoretical model (namely, hostility, threat, dependency, and cohesion).

Two principal questions were asked of the data: Did the starting situation and subsequent interaction, before nuclear diffusion, conform to the model of the cold war? And did changes in the cold-war system, after nuclear proliferation, confirm the predictions of the theoretical model?

Data from the binuclear periods indicate that hypotheses concerning the structural and perceptual characteristics of this situation were borne out at a high level of significance (Fig. 14.5). For example, it was found that there was a high degree of intrabloc cohesion. Nonnuclear bloc members perceived themselves as dependent upon nuclear bloc members.

The combination of dependence and cohesion produced blocs which were hierarchically organized; authoritative decisions tended to flow from the bloc leader rather than from the other bloc members, and the pattern of communication had the properties of a "wheel" communication net. In short, the characteristics of the situation in the first part of the experiment were similar to those of the cold war under conditions of bipolarity.

After the experimentally-induced spread of nuclear capability (the "n-country" situation), data confirmed both the hypothesized changes and the direction of change in the structural and perceptual variables. It was found, for example, that intrabloc tensions increased, and that as intrabloc cohesion was reduced, perceptions of external threat were also reduced. In conjunction with the relative fragmentation of the blocs, significant changes in communication patterns took place. Communication *between* members of different blocs increased; in the n-nuclear system, in contrast to the binuclear system, less-developed nations showed no clear tendency to direct their communication to the economic-military leader of their alliance.

CHAPTER I[1]

Varieties of simulations in international relations research

In the past decade and a half, increasing attention has been paid to the development of methods for the study of politics. The voter-attitude studies have adapted "survey research" techniques in order to gain further understanding of the process of voter decision-making. Decision-making case studies, employing techniques drawn primarily from social psychology, have attempted to add the weight of rigor to the arguments of those political theorists who postulate a "group theory of politics." Content analyses have been employed by political scientists in examination of the theoretical foundations of their own literature as well as to systematically analyze governmental documents and other political data. Simulation or gaming, as a method of analyzing political interaction processes, is another of these post-war developments.

The Northwestern Inter-Nation Simulation is but one among a growing number that have been developed by students of international relations. Our task now is to describe a number of these and to examine the purposes for which they have been constructed and operated. In order to ground the discussion in the growing concern over scientific method, the logic of simulation will be considered briefly. Since political simulations are a type of "operating model," the concept "model" will be explored first.

1.1 Models in Science

A "model" is a collection of assertions about some reality—past, present, or predicted. It is a set of statements which purports to describe patterns of relationships holding between components—units and variables—of that reality. But a model is less than a total representation of the details of the phenomena of interest to the model builder. Otherwise, the scientist would work directly with the phenomenon itself in its total richness. Model building is an attempt to achieve parsimony in the representation of a range of unique and particular phenomena.

A model is a scientific tool. If a model is to be useful for description, explanation, or prediction, there must be some manner of correspondence between the model and the reality it represents. Developing a model involves abstracting from reality those components and relationships which are hypothesized as crucial to what is being modeled. Important detail is included in the model to the exclusion of redundant and distracting detail. "The better the theory, the more knowledge we have about the conditions under which neglected variables do or do not make a difference" (Brodbeck, 1959, p. 381). Do outcomes in the model so resemble outcomes in the reality it purports to represent as to warrant making inferences about aspects of the reality by using the model? The confirmation or disconfirmation of a model, via this pragmatic test, informs the theorist about the adequacy of his abstraction, and, thus, about the usefulness of his abbreviated theory to cope with reality.

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[1] This chapter appears in H. Guetzkow, *et al., Simulation in International Relations: Developments for Research and Teaching,* © 1963. Prentice-Hall, Inc., Englewood Cliffs, N.J. Reprinted by permission.

1.2 *Types of Models*

It seems useful to distinguish between classes of models. The four types of models identified here "Pictorial," "Verbal," "Mathematical," and "Simulational," are those commonly found in use in the social sciences but they do not exhaust the universe of the possible.

1.2.a PICTORIAL MODELS

Pictorial (or iconic) models have enjoyed wide currency among social scientists. Consider, for example, the numerous organization charts found in a basic political science text. Here, by the use of a few symbols (lines for channels and boxes for units), patterns of authority and subordination are described, the "path" that a bill follows through the House is traced, or certain aspects of the interrelations of the branches of government are illustrated. "Since early times," Deutsch points out, "men have tended to order their thoughts in terms of pictorial models. The model itself . . . served more or less efficiently, to order and correlate men's acquired habits and experiences, and perhaps to suggest a selection of new guesses and behavior patterns for unfamiliar situations" (1951, p. 232).

Pictorial models seem to be used primarily for description. They are essentially static and do not yield easily to the deductive logic necessary for prediction. While they can be very useful for depicting order and flow, as Meadows points out, "in the long-run it is not possible to evade this limitation on all pictorial models; relations cannot be readily pictorial" (1957, p. 7).

It is interesting to note that pictorial models usually need to be elucidated with words. Often the social scientist uses a verbal model to construct a "meta-theory" within which the pictorial model explicates limited and particular features of a broader schematization. Hence, the common use of diagrams in texts, which exploit the iconic features of a two-dimensional representation, but simultaneously remedy its defect by complementary verbal material.

1.2.b VERBAL MODELS

Verbal models, if they are more than just word pictures, have several advantages over pictorial models. It is, for example, possible to describe relationships between units in ordinary language which could not be pictured. Furthermore, it is possible to imbue verbal models with a logical consistency which admits deductive predictions.

Verbal models abound in political science. The *Republic* is a verbal model of Plato's conception of the ideal state. Beyond this, it contains descriptions of an actual state of affairs. It proposes a series of steps which it predicts, if followed, would accomplish the transformation of the present reality into the ideal system. In recent times, Easton, Dahl, Key, and other authors have contributed to the store of verbal models at the disposal of the political scientist—unquestionably this type of model has been the principal tool of the discipline. Bentley and Truman offer similar but separable models of "political process." Here the units are groups of individuals; the models purport to describe the relationships between these units with the end of explaining and predicting the process.

Despite the advantages of verbal models over pictorial models, they also suffer from significant disadvantages. It is difficult, for example, to draw cumulative knowledge from verbal models because of the ambiguities of the symbol system. The same word, in the systems of two different theorists, may have substantially different meanings. The terms of relationship (e.g., "more than . . . ," "before . . . ," "correlates with . . .") are suggestive but without precision. Moreover, the development of crucial experiments from verbal models generally involves the translation of the verbal symbols into a more explicit symbol system. One result of this type of translation can be a mathematical model of the system formerly described by the verbal model.

1.2.c MATHEMATICAL MODELS

Mathematical models of political systems are of relatively recent origin. They are, as Beschers puts it, "constructed by abstracting the properties of some data by measurement, and by expressing these properties in a set of symbolic statements that include the logical relationship that holds for the entire set of statements" (1957, p. 33). Richardson's "Mathematical Psychology of War," although published in 1919, lay unnoticed until quite recently. In the past few years several authors, including Dahl, Downs, Matthews, Shubert, and Simon, have contributed to our meager stock of mathematical representations of political phenomena.

To utilize mathematical models, the human behavior symbolically represented in its equations must be so structured that the relationships among the units and variables involved do produce consequences which are isomorphic to the reality one portrays. Sometimes one seeks to have the very rules of relationship which constitute the axioms of whatever calculus is being used correspond to the social processes themselves. Whenever the consequences fail to produce the reality—or under the more rigorous requirement, whenever the processes as well as the consequences fail to mirror the empirical social system one is attempting to represent—alternative calculi may be sought, so that the model may become a more adequate representation of the system of human behavior being considered.

Where appropriate mathematical models can be found, they are powerful scientific tools. The abstractness of the symbol system facilitates the recognition of similarities and congruences between models and, therefore, between the realities they represent. In this way the process of accumulating knowledge may be expedited.

Beyond this advantage, mathematical models can be made to yield information about a variety of states of the system without changing the basic model. The question: "What happens when the 'size' [or 'power,' or some other variable] of a unit changes with respect to the system?" can be explored in the model. And this question can be asked and examined for many combinations of units and variables.

In order to derive full benefit from this feature of mathematical models, it is desirable to be able to "try" a large number of parametric values or to "try" one set of parameters over spans of time. To facilitate this kind of manipulation, mathematical models can be programmed on high-speed computing equipment—the mathematical model thereby becoming one type of "operating" model—in this instance, a "computer simulation."

The heavy reliance of mathematical models upon verbal supplements is noteworthy. The variables posited in the equations are often explicated through verbal language. The measurements used to secure precision in handling these variables are operationalized in verbal language, too. And sometimes the relationships among the equations, especially when discontinuities and contingencies are being handled, are expounded by verbal means. Often the invocation of "simplifying assumptions" when the mathematics become intractable is explained by verbal meta-theoretical considerations.

1.2.d SIMULATIONS

Simulations are physical and/or biological representations of systems which attempt to replicate sociopolitical processes. They are models which yield information about unit and variable changes over time. The theories they incorporate, therefore, include propositions about time-change in the system.

As empirical social systems are difficult to manipulate, the social theorist perforce is dependent upon the "natural" experiment or some substitute in carrying out his confirmatory studies. The "natural" experiment has the advantage of providing data from the empirical system itself. Here the researcher can observe the operation not of a model but of the actual system; validity is assured. Natural experiments, however, have two serious drawbacks from the point of view of the requirements of a scientific methodology: (1) an experimental situation cannot always be found in nature which definitively confirms or disconfirms hypotheses, and (2) when natural experiments are found, it is unlikely that they will be found in sufficient number to provide statistically useful samples; reliability becomes a problem (Campbell and Stanley, 1961, pp. 81–98).

"A *simulation* . . . model," according to Shubik, "is amenable to manipulation which would be impossible or impractical to perform on the entity it portrays. The operation of the model can be studied, and from it, properties concerning the actual system or organism can be inferred" (1958, p. 1). The fact that manipulation takes place in a *model* of reality can itself be considered an advantage. Changes in a system can be tried in a "pilot plant," for example, which might prove excessively expensive and dangerous if they were introduced into the full-scale operation. Simulation allows the study of induced variable change in situations where it might be otherwise difficult or undesirable to induce this change—this might be the case for many, if not most, social systems. With simulations, the problem of numbers can be solved by replication of runs. The number of runs is limited primarily by the resources—and the stamina—of the researcher.

The manipulation of simulation models has been termed "pseudo-experimentation" by Helmer and Rescher—"'pseudo,' because the experiments are carried out in the model, not in reality" (1959, p. 48). They contend that

> . . . . pseudo-experimentation may effectively annul the oft-regretted infeasibility of carrying out experiments proper in the social sciences by providing an acceptable substitute which, moreover, has been tried and proved in the applied physical sciences [1959, p. 49].

Simulation offers advantage to the theorist working with models where *time* is likely to be an important variable. The ability to compress or expand time in a controlled fashion offers an opportunity to study the effects of a given variation upon the system in a way which might be otherwise impossible. Thus, it becomes feasible to study foreign policy decision-making in a series of situations where the decision-makers have differentially timed deadlines. Decisions under "normal" circumstances may be different from those made in the face of "ultimata" or "crises"; these time compressions can be simulated.

The advantage of simulation techniques in theory building and testing are summed up in the ideal of "control." Because the researcher is to a large extent "master" of his system, he can work with many of the variables which interest him. He can study consequences of changes in particular subsystems or within the total model. He can evaluate the outcomes associated with a variety of alternative "policies" in relation to any given desired outcome; he can, in short, attempt to represent future states of the system.

Work in simulation involves the utilization of other modes of model-building. Pictorial representation of computing procedures is widespread. The use of ordinary language throughout man-computer simulations places heavy reliance upon verbal models. In developing programs, the computer components in simulation models rely upon mathematical representations. As Guetzkow and Noel (1963) illustrate, to work with simulation as a social scientific tool, it has been necessary to make metatheoretical explication of the hypotheses which are embodied in the operating representation itself. Hence, Noel presents by means of a verbal model the changes made in evolving the inter-nation simulation. Guetzkow attempts to tighten his understanding of the simulation by using mathematical models to explicate the programmed hypotheses embodied in the simulation and by employing verbal hypotheses to exhibit the unprogrammed relationships which were implicitly incorporated in the game by its human participants. Although iconic, verbal, and mathematical devices are very useful in developing a simulation, their limitations are precisely the reason why one moves to an operating representation of the phenomena, using physical and/or biological means for the model construction.

1.3 Political Simulations in the Study of International Relations

Political simulations are developed and used in order to help the theorist explore hypotheses about political systems. Most commonly, political games have been used in working with international political systems. For the student of international relations the experimental manipulation of the object of his study is out of the question at present; he must rely on other methods.

Three subtypes of simulations may be identified: (1) machine or computer simulations; (2) mixed or man-machine simulations; and (3) all-man simulations or games. What varies here is the degree of involvement of human actors in the operation of the model (as "units" or "sub-units" of the model, not as experimenters). The simulations of international political systems, which will be discussed below, come in all three varieties. The three subtypes show similar lines of development and similar *raisons d'être.*

Now let us examine the contributions of a number of the researchers who already have begun to employ simulation techniques in their studies of various aspects of international relations. A variety of simulations have been used with differing emphases on the two basic objectives, theory and training. But, because for either activity the simulation must approximate reality, these researchers have shown concern for furthering the state of knowledge of international relations.

1.4 Computer Simulations

Machine simulations are operational models which have been programmed for high-speed computing equipment. In these simulations, humans are involved primarily in the role of experimenters. A model of decision-making behavior (so-called "rules of action") is included as part of the larger model to replace the human decision-makers found in "man-machine" simulations and "games."

Among social scientists, economists have made the most use of this type of simulation. Milbrath (1958) has suggested the possible usefulness of voting simulation. Pool and Abelson (1961) have demonstrated the feasibility of developing computer simulations which do significantly better than chance in predicting the distribution of voter attitudes toward salient issues. The "Simple Diplomatic Game," developed by Oliver Benson (1958, 1959) at the University of Oklahoma, is perhaps the single instance of a primarily machine simulation dealing with international relations materials. However, more recently Howard (1961) at General Motors has developed an all-computer simulation of a colonial socioeconomic development system, and his colleague Kaehler (1961) has been preparing for the study of problems of international conflict with an analog computer. Abt (1961), at Raytheon Company, has been developing an extremely complex computer simulation of strategic decision-making, which offers promise as a widely applicable social science tool.

The Benson development is a "computer simulation program . . . designed to reproduce in simplified form a number of the features of the international political system" (1959, p. 1). Fundamentally, this simulation attempts to describe "political" counteractions to particular actions in given situations and the effects on situations of a given action-counteraction cycle. The model consists of two sets of variables—action variables and situation variables—and a program which specifies the relationship of variables to outcomes.

The action variables are nine possible acting nations, nine possible target nations[2] and nine possible intensity levels of action.

> The nine actor states used initially are the nine major powers of the actual scene: The United States, Britain, the Soviet Union, Western Germany, France, Italy, India, China, and Japan. The nine target states are chosen from recent tension areas: Korea, Guatemala, Egypt, Lebanon, Hungary, Vietnam, Taiwan, Indonesia, and Iran. The nine intensity levels of action . . . are defined in the program as representing from ten to ninety per cent of effort . . . roughly corresponding to a scale of increasingly serious action [Benson, 1959, p. 2].[3]

The situational variables describe the "state of the system" at any given moment when action is taking place. The relevant variables are: (1) national power expressed in terms of war potential;[4] (2) the distribution of this power;[5] (3) the interest level, i.e., the degree of involvement of one state with another;[6] and (4) the propensity to act (or counteract) of each actor state.[7]

---

[2] The number of acting states and target states is arbitrarily limited by the storage capacity of the particular computer being programmed (IBM 650, in this case). Theoretically, any number of states for which the requisite data are available could be employed.

[3] The nine intensity levels of action are named "to make them more vivid":

0.100 Diplomatic Protest
0.200 United Nations Action
0.300 Severing Diplomatic Relations
0.400 Propaganda-Subversion Campaign
0.500 Boycott and/or Reprisals
0.600 Troop Movements
0.700 Full Mobilization
0.800 Limited War
0.900 All-out War (Benson, 1959, p. 2).

[4] Eight determinants of war potential are used: "Military age manpower, transportation, gross national product, gross national product per capita, energy production, steel production, literacy, and atomic capability" (Benson, 1959, p. 4).

Benson has developed his model by tentatively accepting certain propositions about the relationship of action-inputs to outcomes, given various situations. For example, the "nature of the universe," as defined by the distribution of power, sets the counteraction behavior pattern of states by specifying the "rules" by which the "game" is being played. Benson has simplified and programmed the "rules" specified by Morton Kaplan (1957) for three "empirical" systems of action (balance of power, loose bipolar, and tight bipolar).

A set of "elementary if rigid assumptions" links the interest index into the system: "The degree of interest of one state in another varies directly with the ratio of mutual trade to total trade and inversely with [geographic] distance, and is heightened by alliance and by possession of military bases in the second state" (Benson, 1959, p. 5).

Benson describes one action cycle as follows:

> 1. The action card [which names the state acting, the form of the action, and the place in which the action occurs] is entered in the machine as a 'play.' It informs us that a certain large state has taken an action of a given intensity level against a certain small state, or target . . .
>
> 2. Following the action card, the program automatically selects a logical counteraction for each of the other eight large states in the universe . . .
>
> 3. After the choice of counteractions, the program recomputes the relative strength of the nine actor states and assigns them new war potential indices. By comparing these with the original set, gain or loss from the cycle of activity is revealed . . .
>
> 4. At the choice of the user of the program, the action cycle may substitute the modified indices of power distribution resulting from the previous play for the original set, and use them as the basis for the selection of counteractions. This possibility gives a mildly stochastic touch to the program, since the new array may also change the rules for selection of counteraction . . .
>
> 5. Also at the choice of the user, the program will hold the results of two successive cycles and compare them for relative advantage or disadvantage to the actor state or states. By this choice two persons or teams might operate the program as a competitive game, though this feature is intended to make possible the exploration of alternative strategies rather than simply to entertain [1959, pp. 2–3].

Despite the seeming rigidity of the simulation, the program is such that modifications can be introduced. The basic information which defines the situation can be brought up to date or replaced with other data deemed more theoretically significant. It is also possible to modify the assumptions upon which the program is built to admit new hypotheses about the international system.

---

[5] Based on "power distribution . . . if two coalitions are dominant to the extent of controlling 75 per cent of the power, the universe is called loose bipolar. . . . If two coalitions are dominant to a marked degree—controlling 90 per cent of the strength—the universe is tight bipolar. . . . If power distribution is even to a given degree [i.e., if less than 75 per cent of the total power is controlled by any two coalitions] the universe of action is defined as one of balance of power" (Benson, 1959, p. 4).

[6] "Interest" is determined by an index of four interest indicators: "trade, coalition membership, presence or absence of military bases of the actor in the target area, and geographic proximity" (Benson, 1959, p. 5).

[7] "Data on *propensity to act* (initially based on Q. Wright's field theory indices of social, economic and political conditions: such labels as aggressiveness, militarism, flexibility, tension, stability, violence, defensiveness, frustration, and internationalism will be arbitrarily attached to weights intended to measure the probability of overt action)" (Benson, 1959, p. 2).

In this exercise, as in all computer simulations, the computer itself is a drudge; any outcomes derived from the model could also result from paper-and-pencil operations. However, and this is the principal argument for using computing equipment, the full exploration of the model would be impractical without the capability of rapid repeated operation of the model which computers can afford. Practically, the insights into the logical implications of the model can hardly be gained in another manner.

Benson's simulation, for all its virtues, has only slight provision for accommodating human decision-making. By design, once an action-input has been selected, the outcome is in the lap of IBM. The "competitive" variation of the game holds the prospect of providing data on human reactions to various states of the international system. The further development of this variation will, however, alter the character of this game—it then becomes a "man-machine" simulation.

1.5 *All-Man Simulations*

1.5.a A SHORT, SIMPLE EXERCISE

The polar opposite of Benson's "mostly machine, very little man" simulation is Charles McClelland's "mostly man, very little machine" World Politics Game. The purposes of these two operating games are also nearly opposite: Benson says that, "the game as designed is a pattern for testing general subjective statements about the international behavior of states" (1958, p. 1). McClelland indicates that his simulation

> . . . . is conceived as an educational exercise. It is intended to build interest in the geography of world affairs, to increase sensitivity to the disparities in the distribution among countries and regions of resources and capabilities and to provide simulated experience with some of the strategies of statecraft. Perhaps the most important function is to encourage imaginative and manipulative constructions of possible international systems [1959b, p. 1].

The McClelland exercise is played by two opposing teams (of from one to *n* players each). Play takes place on a map of the world which has been divided into twenty regions. Each team selects a "nucleus region" or home base and four additional associated regions; these two groups of five regions comprise the initial territory and resources of the opposing blocs. The remaining ten regions become the "targets" for a series of diplomatic-military "moves." A sequence of three moves completes a period or "decade."

"The decision-makers . . . are free to carry on several kinds of strategies according to their own preferences and hoped-for outcomes. A player can be aggressive or passive; he can attempt to cooperate or engage in conflict; he can back a 'United World movement.' . . . In general, the player decides the kind of action [he] will pursue" (1959b, p. 3).

There are four classes of moves: political crises, economic offensives, propaganda-subversion moves, and "United World" movements; these are roughly analogous to Benson's "intensity" levels. The style of play, the specific level of commitment, and the reaction to a given move are determined by the decision-makers. Where the teams have multiple memberships, the internal debate over initiatory and response strategies and the "feedbacks" from the outcomes of moves can perhaps add new dimensions to the student's perceptions of foreign policy-making.

Two classes of capabilities are employed in the game—"Basic Capability" and "Military Capability."[8] A team's total capability is derived from the potential held in the "nucleus region" and the five associated regions.

During play a team makes a move—of a given intensity level—toward a target region, thereby establishing initiative in the area. By "bidding up," i.e., by committing even more capacity, the opposing team can attempt to wrest the initiative. Since each team defines its own interests in a given region, it will also decide when it has made its ultimate "bid"—the team with the largest commitment in a region is the "initiator" of action. When action has ceased, a "crisis outcome" is determined. There are probabilities associated with possible outcomes and the determination of the outcome is made stochastically—an element of uncertainty is thus added to the game. For example, in the political crisis the "odds on the outcome cards are: 1 in 2—initiator wins; 1 in 4—defender wins; 1 in 6—war; 1 in 12—status quo ante" (1959b, p. 3).

The provisions in the simulation for decision-making in the face of uncertainty heighten the "realism" of the experience for the students. They also tend to make the game useful for checking certain hypotheses about strategic behavior, proposed by the "Theory of Games," against the actual behavior of participants in the game.

1.5.b ROLE-PLAYING—CRISIS-PLAYING GAMES

The type of political simulation represented by the RAND exercise has enjoyed the widest currency of any of the games reported in this volume. Variations on the basic RAND theme have been employed at MIT, Columbia University, West Point, University of Wisconsin, and the Air Force Academy. Because of the basic similarity between these exercises, the fundamental game will be discussed in the RAND context, with other variations being noted.

Beginning about 1954 there began to be developed at the RAND Corporation a conception of political gaming which may be characterized as "Role-Playing—Crisis Playing." "RAND's interest in political gaming grew out of work in political analysis and previous experimentation with the use of gaming techniques for other purposes" (Goldhamer and Speier, 1959, p. 72). Attempts at devising a quantifiable Cold War game (presumably, some sort of machine simulation) were abandoned as "unproductive" according to Goldhamer and Speier. The present technique was settled upon.

Goldhamer and Speier offer the following description of the prototypic game:

> The government of each country was to be represented by a separate player or group of players. (In practice, of course, all countries never were represented, but only those regarded as most significant for the geographical or problem area around which the game was centered.)
>
> In addition, 'Nature' was to be represented by an individual or a team, and there was to be a team of referees. The role of 'Nature' was to provide for events of the type that happen in the real world but are not under the control of any government: certain technological developments, the death of important people, non-governmental political action, famines, popular disturbances, etc.
>
> Participants in the game were to be area specialists who could draw upon their knowledge and accumulated area experience. With the exception of the American Team, all

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[8] "Basic Capabilities. The real life reference is to the material resources, government and social organization, industry, science, etc., that support a society. BCs are units of fundamental wealth and strength of the region. Each region also has MCs or Military Capabilities. The term military is defined broadly to include armed strength but also the persuasive and organized abilities that can be used to change, direct, or control the international behavior of the other [team]" (McClelland, 1959b, p. 2).

government teams were to act as they judged 'their' governments would in the circumstances prevailing at any given time of the game ('predicted strategy'). The American Team was less restricted; it was permitted to pursue any strategy which it judged to be optimal; in particular, the United States Team was not required to follow the foreign policy line of any administration or to have special regard for the constraints placed upon American foreign policy in reality by domestic considerations. The game was thus designed to permit tests of a wide range of United States strategies.

The referees had the task of ruling on the feasibility of each move; that is, they were to disallow any move that they did not regard as within the constitutional or physical power of the government proposing it. For three reasons the referees also played the role of 'Nature.' This arrangement saved manpower; it restricted the number of arbitrary moves which might have been made had full-time players represented 'Nature'; and it permitted the referees to make certain non-governmental moves which constituted indirect, partial evaluations of the state of affairs that had been reached at any chosen point of the game. For example, the referees could introduce such evaluations in the form of press roundups, trade union resolutions, intelligence reports, speeches made in the United Nations, etc. (The governmental players were permitted, however, to challenge the plausibility of such moves.) . . .

Prior to the start of gaming, considerable time was spent on the preparation of a 'scenario' and 'strategy papers' [1959, pp. 73–4].

The "scenario" and "strategy papers" are important devices for setting the stage for the game. In the first few "runs" the historical present was used as the starting point for the game; however, for several reasons—e.g., the "overtaking" of the game by real world events and the consequent "noise" introduced by the nongame press—it became desirable to project the game further into the future. The scenario for the "Fourth Game" described a "future" some nine months hence which became the starting point for the exercise. The scenario and "Nature" team are useful for inducing the sense of urgency essential if strategic decision-making in crisis is to be simulated.

The strategy papers record the moves of the teams both projected and actual. A set of these papers is prepared prior to the run, based on information contained in the scenario; during the run, revisions in these papers can be made and/or totally new strategy papers can be executed.

The strategy papers are a major information variable in the game. By "classifying" or "declassifying" papers or by "leaking" or "withholding" their content, the "Nature" team and, to a lesser extent, the several government teams can control the amount of information extant in the system.

According to Goldhamer and Speier,

> The game was so designed as to meet six main requirements:
>
> 1. *Minimal formalization*: The government teams were not limited to any prescribed set of moves . . . nor did the game contain any preestablished prescriptions automatically entailing certain consequences from particular types of moves . . .
> 2. *Simulation of incomplete and incorrect information*: In foreign affairs, state secrets, which all governments keep with varying degrees of success, are important obstacles in the process of decision-making. In our game the introduction of "game-classified" moves and their unpredictable handling by the referees tried to take account of this factor.
> 3. *Simulation of contingent factors*: In political life many events are beyond the control of the most powerful actors, a fact designated in political theories by such terms as *fortuna*, "chance," "God's will," "changes in the environment," etc. We tried to simulate this fact by moves of "Nature."
> 4. *Plausibility of game events*: We vested insurance against implausible game events not only in the political judgment of the referees but also in that of the participants responsible for governmental moves . . .
> 5. *Clarification of issues*: Our aim was not to move on rapidly from point to point of the game but to clarify by discussion the issues

> raised in the course of play. Such discussions took place during the game within each team before a move was proposed or on occasion between a government team and the referees, and after the game among all participants . . .
>
> 6. *Exploration of novel strategies*: We tried to stimulate efforts to meet this requirement by prescribing "predicted" and "optimal" strategies respectively to various teams in advance of the play [1959, pp. 75–7].

There is a series of points-of-entry which admits variations in the RAND system. The particular variation used reflects the goals and facilities of the group conducting the simulation.

The most common variation has been in the "credentials" of the participants. Where RAND used "area experts" to staff the countries of their *expertise*, several similar exercises have not. When the primary goals of gaming have been pedagogical, students rather than experts have been the participants. Some of the MIT exercises have used graduate students; several of the games there and at other institutions have used undergraduates to staff the nations.

At MIT both the student participants and their instructors who conducted the exercise, agreed on the value of political gaming for instructional purposes (Bloomfield and Padelford, 1959, p. 1114). Bernard Cohen reports similar positive results from his Wisconsin simulation in Spring, 1960.[9] However, he qualified his endorsement of the technique, noting that benefits seem to vary directly with the amount of background information one brings to the game. Thus far, there have been no performance comparison data upon which judgment can be based. Given the RAND conception, this is not really a question. Since the values of political gaming for RAND derive from the confrontation of expert-with-expert, the focus of nonexpert runs is, by definition, pedagogical.

A second source of variation in the basic game comes through the selection of differential "game times." The RAND runs were grounded in either the actual present or in the very near future. There is, however, no logical reason barring the choice of games further in the future, or, for that matter, in the historical past. Goldhamer and Speier have speculated that "such a game, removed from the immediate political reality, could conceivably lead to the discovery of entirely new problems and to new insights and provide a greater emphasis on analytic results or generalizations" (1959, p. 82).

If the results of "future-oriented" games are to be more than merely suggestive, independent replication runs may become necessary. Thus far, the only example of the multiple gaming of a single scenario seems to be the runs Lucian Pye (MIT), Warner Schilling (Columbia University), and Major Abbott Greenleaf (West Point) conducted in 1960 with undergraduates at their respective institutions. The results of this replication exercise, unfortunately, have not been reported as yet.

Professor Cohen's variation consists in increasing the impact of "domestic" considerations upon foreign policy-makers. This was accomplished by creating a game within the game, that is, within the over-all international relations game is a United States internal-political game. By this technique the players representing the American Team in international affairs had to defend their policies not only to the referees but also to a "Congress" and an "Executive" within their own nation. Optimum strategies had to be found which would satisfy the values of "national elites" (who, in turn, had reference groups of their own) as well as the values of the policy-makers themselves. This is a more complex political environment than is ordinarily found in this type of game.

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[9] Cohen, Bernard J., personal communication, November, 1960. See also (Cohen, 1962).

The exercise conducted at the Air Force Academy apparently modified another aspect of the RAND game. In this simulation no distinction appears to have been made between "predicted" and "optimum" strategies. With the relaxation of the requirement that all nations save the United States follow predicted strategies, the game becomes more flexible and, perhaps, more imaginative. It would probably be the case, in games not grounded in the present, that the tendency would be for *all* teams to follow "optimum" rather than "predicted" strategies.

Other variations on the basic theme are possible. Scholars using the technique have suggested several but they are, as yet, untried. One of the striking features of simulations is that they are equally stimulating to the imagination of the theorist and the participant. New ideas come much faster than the opportunities to try them out.

The claims made for this style of political gaming have been cautious, even with respect to its use in the classroom. As a device for carrying out research, its prime virtue, it is asserted, resides in bringing together talented people and focusing their attention on problems in a more intense manner than would be the case with other methods. *The better the experts, the more thoroughly they become involved in the role, the closer the approximation of reality* seems to be the basic assumption of those who would use the RAND gaming technique for research.

It has happened that moves in the game, which have appeared to be of dubious legitimacy to the referees, subsequently have come to pass in the real-world, equivalent situation. However, even when this kind of "prediction" has resulted, systematic "explanation" has not. The focus of the RAND games has been on the exploration of strategies, not theories.[10]

1.5.c MAN-MACHINE SIMULATIONS

It is quite possible to mix men with machines to develop complex forms of simulation, as has been done as a deliberate strategy in the Northwestern Inter-Nation Simulation. In this way, an effort is made to reap the benefits of both ways of constructing the operating model. Those parts of the theory in which knowledge is more adequately developed may be programmed for the computer; those aspects of the model which fall on the ambiguous, implicit side may be represented by human participants. Just as the Benson system simulation represents the "mostly machine, very little man" end of a continuum, and the McClelland-RAND-Bloomfield-Padelford crisis game represents the other end, "mostly man, very little machine," so the simulations developed by the Operations Research Office (Harrison and Lee, 1960) and Northwestern (Guetzkow, 1959) may be located in the middle range of this continuum, "partly man, and partly machine."

It seems useful to describe the mixed simulation in the context of model building, contrasting these models with the all-man games developed by Schelling (1960) and by Kaplan, *et al.*, (1960). Experience with simulations that have hypothesis "testing" as their primary focus has, thus far, been limited. In part, this reflects the relative youth of simulation methods. It also reflects the "state of the discipline" of international relations.

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[10] In many respects the RAND game approach is epistemologically related to "single case" studies of empirical systems. The approach exhibits the advantages and limitations of the single case method (Paige, 1959).

1.6 *Theory Playing—Simulation and the Exploration of Hypotheses*

In this section, three quasi-experimental simulations will be examined: (1) Morton Kaplan, Arthur Lee Burns, and Richard Quandt's use of gaming to study "balance of power" systems (Kaplan, *et al.*, 1960); (2) Thomas C. Schelling's study of bargaining and limited way (Schelling, 1960); and (3) Joseph O. Harrison and Edward M. Lee's man-machine simulation of strategic (military-political) problems (Harrison and Lee, 1960). A fourth study, Harold Guetzkow and Richard A. Brody's exploration of the *n*-country problem" with the inter-nation simulation, will constitute the core of this report. The application of simulation techniques to systematic research in international relations is of such recent origin that no study (these three included) has as yet formally reported out its complete data. The following presentation is based on the statements of the authors prior to the completion of their respective studies and is necessarily tentative in its conclusions.

Kaplan and his co-authors have as their major purpose to "examine the balance of power international system in terms of a restricted set of variables" (1960, p. 240), in order to build toward a theory of this system. More specifically, they are engaged in an attempt to "bring out and examine the stabilizing and other potentialities attributed to the 'balance of power' system" (Kaplan, *et al.*, 1960, p. 240).

Kaplan points out:

> The term 'balance of power' has been used in the literature and makes intuitive sense if it is applied to the description of the international system that persisted throughout the eighteenth and nineteenth centuries and perhaps the early part of the twentieth century. . . . The 'balance of power' system is characterized by the following set of essential rules [which characterize the behavior of the national actors]:
>
> 1. Act to increase capabilities but negotiate rather than fight.
> 2. Fight rather than pass up an opportunity to increase capabilities.
> 3. Stop fighting rather than eliminate an essential national actor.
> 4. Act to oppose any coalition or single actor which tends to assume a position of predominance with respect to the rest of the system.
> 5. Act to constrain actors who subscribe to supranational organizing principles.
> 6. Permit defeated or constrained essential national actors to reenter the system as acceptable role partners or act to bring some previously inessential actor within the essential actor classification. Treat all essential actors as acceptable role partners [Kaplan, 1957, pp. 22–3; cf. Brody, 1960b, pp. 14–8].

Having thus described a "balance of power" system in this earlier work, Kaplan and his co-authors proceed to seek answers to questions about the "stability" of the system.

> Is the system stable—that is, does it have the property that it tends to be maintained as a system of independent nations, characterized by groupings into rival transient alliances; or does it tend to be transformed into a different system, either by a reduction in the number of states or by aggregation into a system of relatively *permanent* alliances? Or will the system be unstable or stable depending upon the conditions or assumptions built into the system? Is there some lower bound upon the number of nations necessary for stability? An upper bound? Since stability obviously depends in part upon the behavior of the members of the system what motivations or mechanisms trigger the behavior that makes for stability? [Kaplan, *et al.*, 1960, p. 240, emphasis added.]

These questions, the authors feel, cannot be answered in the natural setting, i.e., in the ongoing or historical international system. In order to develop answers, a competitive international political or balance of power game was constructed. In the authors' words, the game is

> . . . . a means of displaying the formal properties of any one of a family of models—viz., of those which assume that the 'balance of power' and other international systems are (i) essentially competitive and cooperative at once, (ii) essentially responsive to military force or the threat of it, and (iii) sensitive in the long run to change in their constituents' economic potential, from which alone their military forces are produced.
>
> The object of our game, therefore, must include both competitive and cooperative ends, though the proportion or mixture of these should be variable. The rules must allow for the possibility of making war. . . . And last, the equivalents for 'military force' to be displayed in the game must flow in the last resort from something equivalent to the instruments of production—the rate of flow again may be varied [*ibid.*, pp. 240–1].

The components of this model are the nation states comprising the international system. For this study the nations were not differentiated internally, the implicit hypothesis being that the internal political system does not constrain the national actors from behaving in the manner prescribed by the rules of the international system. The model further assumes that no political impediments to the decision-making process exist, nor are there any constraints, save economic constraints, on the ultilization of resources.

The decision-makers in the model have complete information about the economic and military resources of the other national actors. Simultaneously, uncertainty about the decisions made by the other nation-states, except where this information is voluntarily transmitted, is also a feature of the model.

The authors specify further assumptions about the nature of the national actors; these assumptions provide a further refinement of the "essential rules" of the system:

> . . . . Each nation dislikes uncertainty, that is, it prefers its present situation to a risky gamble that would improve its position, but [it] would also prefer a still less risky situation to its present one. . . . Each nation desires to maintain its position as an independent nation state, that is, no economies of scale or values dictate either absorption into a larger organization or sacrifice for a different nation [*ibid.*, p. 242].

The operating model is described by Arthur Lee Burns in an Appendix to the main body of the article. There is similarity between this game and the McClelland game discussed above. Both are "board" games with moves characterized by bidding. In the Appendix, Burns offers the following "brief description of the game":

> The players are Nations competing for pieces (chips or dice). Pieces represent units of resources; or they can be set aside as reserved forces which, when 'deployed' on 'frontiers' against other Nations, become 'sources of firepower.' Undeployed resources, i.e., those neither deployed on frontiers nor in the reserve of forces earn proportionate income, but in proportions that may vary by chance from round to round.
>
> Players take turns to move. A move can be passed; or it can be used to deploy, reserve, or withdraw forces, or to 'make war' with forces already deployed. If at war, opposed pieces on a given frontier exchange at a rate determined by throwing the deployed dice and do so until one side's pieces deployed on that frontier are eliminated. The regular sequence of moves is suspended by warfare, until the initial conflict or battle is finished, the victor in that battle has taken some pieces from the defeated, and each contestant has had the opportunity to redeploy and to make war. Players know either that the game will be played to a finish or after a specific number of rounds it will conclude with a payoff which (in either case) will depend on the number of pieces then possessed.
>
> 'Alliance' is supposed to consist in two or more Nations' reciprocal withdrawing of forces from a common frontier(s). 'Pressure' consists in a Nation's increasing the forces deploying against another. Degree of pressure is increasingly a matter of predominance at specific frontiers because of the Lanchester-type exchange-rate in war [1960, p. 247].

Generated from the model are hypotheses which presumably can be explored in the game. These hypotheses concern the stability of the balance of power system, the tendency for wars to be an outcome of political interaction in such a system, the tendency for alliances to form and for the members of the alliances to be rewarded, and finally, hypotheses about the relationship of the number of national actors to the stability of the system.

The following are included as examples of these hypotheses:

> 1. The stability of any balance of power, and the motivation it affords for alliances and other such balancing alternatives to war, are acutely sensitive to the form and intensity of the military exchange rate, and to the power of the weapons to destroy economic resources.
> 2. There is a strong temptation to go to war in order to increase one's national strength in relation to at least some other nations.
> 3. There is some tendency in the system for alliances to form and for alliances to culminate in at least limited wars.
> 4. The nation to whom the alliance is offered knows that it can get a better deal from the nation that is left out. Since that nation does not want to be on the losing end of a war, it will accept less than a 'fair' offer [as the price of alignment] [Kaplan, *et al.*, 1960, p. 243].

The discussion in the article, unfortunately, does not present the research design by means of which the hypotheses about the balance of power are to be explored in the game. However, the constituents of the model are represented in the game. Research on the hypotheses should, therefore, be possible.

Schelling's gaming approach is in many ways similar to that of Kaplan, Burns, and Quandt. The research focus of Schelling is, however, markedly different. Where Kaplan and his co-authors focus on the international system as a whole, Schelling concentrates on the problems of bargaining and limited war. This is one process within a larger systemic context. Schelling describes his project as

> . . . . an experimental study of the bargaining process involved in limited war and other conflicts in which bargaining is by maneuver as much as by words, communication is poor, legal enforcement is unavailable, and the participants make irreversible moves while they bargain, are uncertain about each other's values, and they have the power to inflict gratuitous damage on each other [1961, p. 50].[11]

The "participants" are representative of "actors in a situation" where the "situation" is a variant of the international scene. Thus, the group to whom Schelling would generalize is the group of decision-makers in the cold war system. The bargaining setting constructed by Schelling attempts to be structurally isomorphic with the international system: Deeds, i.e., actions, are likely to be seen as expressive of intentions, communication is less than perfect and information is incomplete, legal sanctions among the units are relatively unenforceable, and self-restraint (or self-interest) is the principal check on violence.

In game theoretic[12] terms the conflict situation in the game, as in the real world, is a "non-zero-sum" situation. In international conflict situations, mutual gains or mutual losses can result from conflict interaction. Or put another way, what one nation gains from an international conflict is not necessarily equal to the losses of the nation it opposes. Conflict and interdependence are thus simultaneous characteristics of the interaction system. It is worth noting that Scodel and his associates find that even when the conflict situation is objectively non-zero-sum, those involved in the situation tend to perceive it and treat it as if it were a zero-sum (pure conflict) situation (Scodel, *et al.*, 1959).

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[11] See also (Schelling, 1960, pp. 99–108).

[12] Models based on the Theory of Games, and the operating models called *political games* are quite distinct entities. The Theory of Games ("Game Theory") provides a means of describing the strategic behavior of one or more actors who have to make choices in conflict situations (games) where the payoffs (potential outcomes) are a function of the choices made by all parties to the conflict. The Game Theory model is normative, in that it prescribes the choice or combination of choices which lead to the best payoff under the circumstances of a given conflict situation. The theory, moreover, postulates a "rational" actor who will always follow this best strategy. A political game (or simulation) is an operat-

The nations (or participants) have at their disposal the capacity to inflict severe damage to opponents. Since this capacity is mutual, it is argued, mutually bargained, nondestructive strategies will be optimal for the participants. This is to say that optimal strategies will consist in the mutual self-limitation on the means of violence in these conflict situations.

It is Schelling's contention that under certain conditions, 'limits' can be imposed on conflict interaction behavior. Where there is a low level of communication between the parties to the conflict, these limits can be imposed through a process of "tacit bargaining," if conditions are right. The proper condition for the functioning of this process is the presence of fundamentally dichotomous circumstances which serve as symbolic boundaries. For example, violent or nonviolent acts, nuclear or nonnuclear weapons, or the participation of advisers but not armed troops, are dichotomous conflict conditions with easily discernible boundaries. Likewise, physical borders (e.g., the Yalu River) partake of this quality. Schelling points out,

> Limits have to be qualitative and discrete, rather than quantitative and continuous. This is not just a matter of making violations easy to recognize, or making adherence easy to enforce on one's own commanders; it concerns the need of any stable limit to have an evident symbolic character, such that to breach it is an overt and dramatic act that exposes both sides to the danger that alternative limits will not be easily found.
>
> The need for qualitatively distinguishable limits that enjoy some kind of uniqueness is enhanced by the fact that limits are generally found by a process of tacit maneuver and negotiation. They are jockeyed for, rather than negotiated explicitly. But if the two sides must strike a 'bargain' without explicit communication, the particular limit has to have some quality that distinguishes it from the continuum of possible alternatives; otherwise there is little basis for the confidence of each side that the other acknowledged the same limit [Schelling, 1960, pp. 261–2].

Schelling's argument can be summarized as follows: Optimal strategies (those which will yield the highest absolute payoff for the participants) require the adherence to limits on the capacity for mutual destructiveness. Given a low level of communication, these limits can be set through tacit bargaining, if the means of conflict and the arenas of conflict exhibit discrete boundaries. Information about the intentions of the opponent will come from perceptions of his activities; the more ambiguous this information source, the less likely will be the finding of mutually optimal strategies. "Boundaries" crossed or conflict means and arenas which contain no clear boundaries are ambiguous information sources and therefore detract from the likelihood of the attainment of optimal solutions by the conflict partners.

"The game," which Schelling developed to explore these hypotheses, "is essentially

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ing model which represents an attempt on the part of the theorist, through the representation of an empirical system, to provide himself with information about states of the real system.

one of 'bargaining by maneuver,' of signalling intentions, proposals, threats, refusals, and information about one's preferences through maneuver rather than through words" (1961, p. 52). Here, as in the Kaplan, Burns, and Quandt game, there is structural similarity to the exercise developed by McClelland. The game employs a map and includes players who vie for territorial control. It is basically a two-person (or two-team) game. However, according to Schelling, expansion of the number of conflicting parties is possible.

Schelling describes this research as "exploratory."

> A good deal of trial and error will be involved in working out the analytic framework . . . the object [at this stage of development] is not to test a set of available hypotheses, so much as to generate hypotheses through exploratory experimentation, to manipulate the game and its environment in an effort to bring the suggested hypotheses into clear relief, and to rationalize the results in terms of a theoretical model that can be identified within the structure of the game [1961, p. 63].

The participants in the Schelling game have available to them a full "spectrum of force," i.e., they can bring to bear in a conflict situation forces to the limit of their resources. There is no differentiation of the "weapons systems" in the game. With the means of destruction a continuous rather than a discrete variable, following the logic of Schelling's theory, we would expect that territorial boundaries will provide the points about which bargains can most easily be struck. By comparison, in Harrison and Lee's research (1960) determining the effects of two contrasting force spectra—continuous and discrete—is the main experimental task.

The "Stratspiel Pilot Model," developed by Harrison and Lee, is a man-machine strategic game which incorporates both military and political factors. The machine itself serves three functions: (1) "computing," i.e., the converting of decisions into the "language" of the model and calculating the results of these decisions; (2) "bookkeeping," i.e., the storage of the results and the combining of them with previous decision-outcomes and the results stemming from the opponent's decisions; and (3) "display," i.e., the feeding back to the decision-makers the outcomes of their own and their opponent's moves. By performing these functions the machine, in effect, serves as the interaction linkages between the humans who serve as decision-makers in the system.

The model, stored in the computer, comprises the decisional setting for the participants.

> The general situation represented by the pilot model is the following. One contestant or the other in a limited war recognizes that he is in an unfavorable position so far as objectives and limitations are concerned. He is tempted therefore either to extend the scope or to relax the limitations, or both, so as to improve his position. But if he unilaterally takes such action the situation is reversed. The opponent or second contestant now finds himself in the same situation that the first contestant was in initially, and must himself decide whether to extend further the scope or to relax the limitations. This sequence of events repeats itself for a number of cycles each leading to a war of broader scope and/or higher intensity than the last. The situation is finally resolved in one of several ways:
>
> (a) One contestant or the other accepts a limited objective and/or a possible loss of the war as being less undesirable than precipitating war on the next higher level.
>
> (b) A compromise is reached in which both contestants accept limited objectives and limited forces as being less undesirable than continuing the spiral of relaxation of limitations.
>
> (c) Both contestants successively relax the limitations and extend objectives until all-out war ensues.

> Which of these alternatives actually occurs depends on each contestant's evaluation of the importance of the expected gains relative to the risks of all-out war and on his estimate of his opponent's views regarding this evaluation [Harrison and Lee, 1960, p. 6].

The objectives in this conflict interaction are (1) to maximize "political control"—operationalized initially in terms of population size and, ultimately, in terms of both the population and geographic power bases—and (2) to minimize the damage to one's "condition"—which can be conceived of as the economic power base. The nature of these two variables is such that the decision-maker is faced with the problem of considering, "whether it is in his best interest: (a) to increase his force allocation so as to increase his probability of winning the incident and thus increase his political control, or (b) to limit his force allocation so as not to provoke his opponent into using more force and degrading his condition" (Harrison and Lee, 1960, p. 7).

The decision-makers have at their disposal force by means of which the opponent can be coerced. Force applied by either player is measured in terms of potential fractional damage to the opponent's "condition." Thus, for example, if one contestant applies force at a level of 0.50, he has the potential of reducing the opponent's condition by 50 per cent; whether this potential is realized or not is randomly determined.

The initial research with the pilot model was designed to "test the effect of limiting the spectrum of force available to one . . . of the players. If one player is constrained to back up his bids for political control with either a large measure of force or none at all, and the other player is permitted to utilize a complete spectrum of force, then one approximates a situation of massive deterrent capability versus a graduated deterrent capability" (*ibid.*, p. 16).

This situation was simulated by depriving one player of the "intermediate" range of force and allowing the other player the full spectrum. It was found that while "restricted force availability on one side tends to moderate the competitive behavior . . . a player who was [so deprived] was at a disadvantage relative to his opponent" (*ibid.*, p. 2).

The principal limitation of this model, which the authors forthrightly present, is the lack of any alternative to violence as a mode of interaction. The model assumes at the outset the existence of limited war. This situation plus the fact that force is a continuous variable—"different types of forces and weapons systems are not specifically considered, the player being concerned only with how much force he should bring to bear on his opponent, not what kind" (*ibid.*, p. 16)—may account for the finding that even though there are non-zero-sum aspects to the conflict situation, cooperative behavior was minimal.

Schelling's theory can help us understand why, when the force spectrum of one party was broken into two clearly separable parts—the gap providing a prominent tacit bargaining point—competitive behavior was "moderated." Nonviolent interaction-alternatives, if included in the game, would provide a still richer spectrum of mutually-bargained solutions.

1.7 *Conclusion*

These three examples are illustrative of the international relations research which might be undertaken with simulations in any of its forms, all-computer, mixed, or all-man. There is no fundamental reason why Benson could not make replicative runs, using an experimental design to test some of Quincy Wright's theories about the determinants of war. Nor would it be impossible for those interested in role-playing crisis games to set up more than case studies of contemporary reality. In fact, in the latter instance, it would seem necessary that such efforts be undertaken in order to avoid being trapped by the idiosyncrasies of the particular scenario used and the special personalities of those who participated as experts.

The materials examined point to shortcomings of simulation as well as to advantages offered. A typical disadvantage of the approach is its potential for misrepresentation due to the lack of empirical grounding of the model. Because little quantitative data has been gathered in the area of international relations (cf. Deutsch, 1960), the parametric loadings of the variables themselves may be quite inadequate. By providing pressure for more or less definitive conceptualization, simulation may force premature modeling in areas in which empirical research has been sparse. In the use of all-man simulations, one may actually be overrepresenting the phenomena, in one's effort to obtain surface richness, thereby seducing the researcher away from his goal of parsimony. On the other hand, it may turn out that the realities of international relations are so complicated that simulation cannot but oversimplify and underrepresent the crucial variables. For example, the distortions of time within a mixed simulation present serious problems which are but little understood. How can the weeks of decision burden, with its concomitant anxiety and pressures, be juxtaposed when there is time compression in the economic factors? Just because one has liquidated certain problems in simulation, one still confronts in common those found by experimenters within all social science disciplines (Festinger and Katz, 1953)—data "quality control" and adequate methodological controls.

On the plus side, simulation offers the opportunity to do exploratory experimentation in many areas of interest which otherwise would not be amenable to systematic study. Beyond this, the technique forces the scholar to come to terms with his theory building. The complementary role of verbal and mathematical theory in the construction of operating models cannot be overemphasized. Verbal theory guides the selection of crucial components. Mathematical theory aids in specifying the relationship between components. As Schelling points out,

> To build a game of this sort and especially to build into the game particular features that one wishes to represent, requires that one define his concepts operationally. A game . . . imposes discipline on theoretical model building; it can be a test of whether concepts and propositions are meaningful, and a means of demonstrating so when they are. In the actual construction of the game, and in discussion of the game's features with persons who have played it or observed it played, it has frequently been the case that certain plausible concepts had to be abandoned when an effort to identify them (or to incorporate them) in the game revealed that they were meaningless, or innocuous, or that they rested on inessential distinctions [Schelling, 1961, p. 57].

A science arises out of scholarly dialectic. In its exploration with simulation, social science may have another method for use in the development of the study of international relations.

1.7.a SUMMARY

To "pictorial," "verbal," and "mathematical" models of social processes have been added "simulational" models. Simulations differ in structure and mode of operation but their developers share a commitment to the proposition that social realities can be understood *via* the study of scaled-down versions of those realities.

Controlled experimentation in international relations is out of the question. Faced with this situation, a dozen or so researchers have put their theories to work in simulation. By means of a variety of techniques, these scholars have sought to gain insights into international political processes.

Whether programmed for high-speed computers or set into motion by human decision-makers enacting roles, a simulational model requires an attention to operationalizing theory that is unusual in social research. In the end this development of operational theory may be simulation's most significant contribution.

The chapters which follow are a presentation of the details of the author's attempt to explore hypotheses about international behavior, using simulation as the vehicle of exploration.

Chapter II is a presentation of the "problem" to be studied—the so-called "*n*th-country problem." Chapter III is a discussion of the experimental design and the adaptation of the inter-nation simulation for the execution of this design. Chapter IV contains the execution of the design—the exploration of a hypothetico-deductive model which predicts effects of the spread of nuclear weapons capability. This is followed by Chapter V which contains a discussion of the question of generalizing from the simulation to the real world.

CHAPTER II

The "*n*th-country problem"

2.1 *Introduction*

The interest of students of society in the military aspects of international politics is not a new phenomenon. Historians at least as far back as Thucydides have chronicled the military-political transactions of states; and they have raised the reporting of these transactions to a high art. Political analysts at least as far back as Machiavelli have been willing to acknowledge processual contiguities between war and politics. Von Clauzwitz's dictum—"War is to be regarded not as an independent thing, but as a political instrument"—is essentially paralleled in the writings of such political philosophers as Hobbes, Marx, and Lenin.

The acknowledgment of an intimate connection between war and politics signals a recognition that military preparation, strategy, and level of capability (one kind of power) are data of consequence in the analysis of international relations. This impression is reinforced by the priority given these items as "bases of power" by the authors of international relations texts.

Further evidence of this interest can be drawn from the burgeoning literature on many facets of contemporary military-political problems, e.g., deterrence, disarmament, arms control, or the "cold war." The thirty-odd books and articles on deterrence strategies analyzed by the author (Brody, 1960a) now represent a small fraction of the total literature.[1] The literature on the so-called "*n*th-country problem" alone is now nearly as extensive as that on *all* aspects of deterrence a few years ago. If the magnitude of writing is an index of interest, there is high interest in this topic. What can be said of the content?

2.2 *Some Key Assumptions in the Deterrence Literature*

Writers on deterrence have been primarily concerned with behavior in the dyad. The explicit units of analysis—i.e., the constituents of this dyad—are the United States and the Soviet Union. The bloc-allies of these two nations are generally seen as acting through the bloc leaders in matters which concern the primary international interaction system. Underlying this point of view are two implicit postulates: (1) "If the Soviet Union is deterred, so are its allies" and (2) "If the United States deters, its allies do not provoke." Thus, cohesion of the two bloc-alliances is assumed.

There is, of course, a literature which holds this "cohesion" problematical (e.g., Wolfers, 1959; Knorr, 1959; Brzezinski, 1960; Modelski, 1960; Osgood, 1962) but, by and large, there has been little overlap between it and the deterrence literature.

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[1] Charles Osgood (personal communication, April, 1962) estimates that over 3,000 journal articles will have to be examined for his survey of the psychological assumptions in the strategic literature being done for the Institute of International Order. Osgood is not attempting to cover books in this survey. An impression of the magnitude of the book literature on this subject can be gained by strolling through Brentano's Pentagon branch—it is awesome!

The concentration of focus on the United States-U.S.S.R. dyad is not without rationale, given a desire to understand the contemporaneous international system. In terms of a statistical metaphor, the behavior of these two national actors is a major source of variance of the behavior of the entire system. To acknowledge this state of affairs, however, it is not necessary to agree with Morgenstern's contention that "the fundamental tendency toward bipolarity will remain a characteristic of the power game . . ." (1961, p. 208).

With certain notable exceptions, writers on deterrence have not looked beyond the thermonuclear dyad. The tendency among those who *have* examined the "$2 + N$" nuclear-power world has been to multiply the sources of danger in the present conflict system by "N," i.e., to essay the "nth-country problem" *qua* problem. They reason essentially in the following manner: "There are serious problems facing the two major powers, e.g., the stability of the deterrent relationship, the potential for accidental war, and the difficulty of achievement of a disarmament *rapprochement*; these problems will be exacerbated with an increase in the number of nations with control over nuclear weapons."

2.3 *Inventory of Propositions About the Nth-Country Problem Extant in the Literature*

In order to support the above characterization of the reasoning on this topic, an inventory of propositions drawn from the literature will be presented. These propositions cluster in four general categories: (1) problems occasioned by the spread of nuclear weapons capability; (2) national motives for seeking nuclear capability; (3) effects of spread on the international system; and (4) the feasibility of nuclear diffusion taking place.

The propositions will be rank-ordered, within categories, from "least specific" to "most specific." The propositions, in all cases, are presented as direct quotations. This is done in order to avoid possible inaccuracy of paraphrase and to communicate the *flavor* of the literature. The hypotheses to be explored in this study will be stated later on in this chapter; at the time of that presentation, parallels between propositions from the literature and the hypotheses under examination will be indicated.

The presentation of these propositions without comment should not be construed to mean that the author is satisfied about their "truth status." Some of the propositions are mutually contradictory; a fact which emphasizes the need for empirical research.

2.4 *Propositions Which Predict Problems Occasioned by the Spread of Nuclear Weapons*

2.4.1 The spread of nuclear weapons will create problems of which our current ones are pale shadows [Morgenstern, 1961, p. 136].

2.4.2 The nth-nation problem . . . promises to be practically an infinite series leading to a catastrophic divergence [Inglis, 1959, p. 25].

2.4.3 . . . a further increase [in the number of nuclear powers] would make the international situation and the achievement of a general disarmament more difficult [U.N. Review, 1960, p. 16].

2.4.4 The fewer fingers on nuclear triggers, the fewer chances of their being pulled [Doty, 1960, p. 824].

2.4.5 With many countries possessing nuclear weapons, the possibility of nuclear war obviously increases [Kissinger, 1961, p. 242].

2.4.6 The spread of nuclear military capability will almost certainly decrease the stability of deterrence systems. The greater the number of nations that possess the capability of launching a nuclear strike, the greater the probability that there will be a strike [Brown & Real, 1960, p. 25].

2.4.7 To upset the existing [deterrence] balance . . . all [a nation not aligned to the U.S. or U.S.S.R.] has to do is produce a sufficient quantity of conventional nuclear bombs [Morgenstern, 1961, p. 137].

2.4.8 [With the spread of nuclear weapons] the probability of war by 'mistake' as well as by deliberation is likely to increase. Vulnerability to attack and the incidents of 'mistakes' can . . . be affected by the way we shape our posture, including our decision-making processes. However, the proliferation of nuclear forces has an essential connection with the difficulty of solving these two problems simultaneously. It places an increased burden on a system of positive control, and therefore increases the problem of its protection. The dispersion of nuclear weapons complicates the problem of responsible deterrence by increasing the ambiguity as to source of attack [Wohlstetter, 1961, p. 371].

2.4.9 There is no question that increasing the number of nations armed with nuclear weapons will add to the risks that some local outbreak of violence will spiral into all-war [Hilsman, 1959, p. 168].

2.4.10 According to the 'statistical theory,' the probability of a global thermonuclear war increases as the number of nuclear powers increases, because (a) the larger the number of these powers, the greater the probability that nuclear weapons will be used in some conflict (both because of more opportunities and a greater chance of irresponsibility); and (b) if nuclear weapons are used in the conflict, the risk of its expanding into a global war is greater than if the conflict remained nonnuclear [Iklé, 1960, p. 391].

2.4.11 The increasingly widespread possession of nuclear weapons will have the general effect of aggravating the security problems nations face. For the spread of nuclear weapons will almost inevitably result in an ever greater dependence on these weapons and a decreasing dependence and emphasis on conventional weapons [Tucker, 1962, p. 6].

2.4.12 The danger in the spread of nuclear weapons is more than greater power. The leaders of the irresponsible smaller nations . . . would have to do more effectively what they can already do in part. These leaders already have the power to start wars that might involve the big two and so start a spiral into a world struggle. With atomic weapons at their disposal, they might be more than ever tempted to adventure, and the wars that they fight will be incomparably more destructive. But the greatest difference would seem to lie in the fact that the line between conventional and nuclear weapons would have already been passed before the great powers got drawn into the fight and the difficulties this would create in confining it [Hilsman, 1959, p. 169].

2.4.13 With the multiplication of national strike forces, the control problem becomes especially acute. If many nations have the power of decision, and if, in addition, each nation decentralizes its control to a multiplicity of subordinates . . . it is evident that the situation can get out of hand very easily. The difficulty of distinguishing accidents from attack or, if the attack is actual, in identifying its source, would be enormously increased. Diffusion, therefore, places increased burdens on control [Wohlstetter, 1961, p. 363].

2.4.14 The problem of achieving international arms control will become vastly more difficult when the three powers now having nuclear weapons are joined by a fourth and then a fifth and possibly more [National Planning Association, 1958, p. 39].

As counterhypotheses the following propositions are offered:

2.4.15 Of itself, the possession of nuclear weapons should not increase the willingness of a minor nuclear power to go to war against a major opponent [Kissinger, 1961, p. 242].

2.4.16 The counterargument [to the 'statistical' argument] is that the diffusion of nuclear capability might make the involvement of major powers in global conflicts appear to be more risky and hence render it less likely. In other words, *n*th country capabilities might either help to deter local aggression altogether or they might help to isolate local conflicts [Iklé, 1960, p. 391; cf. prop. 2.4.10].

2.5 *Propositions About National Motives for Attaining Independent Nuclear Capability*

2.5.1 The spread of the fission weapons is itself a kind of 'fission process'; each nation that acquires weapons induces more nations to get them too [Morgenstern, 1961, p. 137].

2.5.2 [Our hopes for a strengthened European force and disarmament through the United Nations] have not been fulfilled . . . some countries have been allowed to set up gigantic nuclear armaments. Under these circumstances, it became indispensable to provide the French forces with a nuclear armament [Ambassade de France, 1960, p. 3].

2.5.3 . . . if France wanted to maintain its military position as a major power at the precise moment when inevitable changes in the concept of war became essential because of atomic developments [then she would have to develop nuclear weapons] [*ibid.*, 1960, p. 8].

2.5.4 . . . for Britain and France, the decision turned not only on strategic but also on political and economic considerations, prestige, influence in Washington, commercial interests, and scientific ambitions, as well as other reasons only remotely related to the Russian threat [Doty, 1960, p. 819].

2.5.5 Nations want [nuclear weapons] for a variety of reasons . . . for prestige . . . for increased security . . . for aggressive purposes . . . [Morgenstern, 1960, p. 137].

2.5.6 The possession of nuclear weapons has become a symbol of being a great nation, influential at the council table [Inglis, 1959, p. 26].

2.5.7 A motivation [for obtaining independent nuclear capability] has been the impression that 'deterrent independence' will also allow Britain a freedom of action in world affairs that she could obtain by no other means [Burns, 1961, p. 190].

2.5.8 A nation may be attracted toward a nuclear development of its own . . . not only because nuclear weapons mean power, honor, and a fuller sovereignty in general in our time, but also because in particular a nation so equipped can now itself make the key decisions, to defend itself with these weapons and pull its allies into the fight [Miller, 1959, p. 37].

2.5.9 The chief motivation for the acquisition of nuclear capability within a coalition, and for neutrals who might join a coalition, is the payoff associated with greater control over future decisions [Snyder, 1961, p. 71].

2.6 *Propositions About Effects of the Spread of Nuclear Weapons on the International System*

2.6.1 The fortunes of nation-states, and likewise the structure of their relationships, should change with changes in the instruments of military art [Burns, 1961, p. 187].

2.6.2 If the diffusion of nuclear weapons continues unchecked, the structure of international relations will be profoundly altered [Kissinger, 1961, p. 240].

2.6.3 . . . we might foresee a world in which gradually more powers became independent nuclear powers in their own right. . . . Assuming that the control exercised by a bloc over its constituent members would be very tight, it would seem likely that the process would come to an end in a very rigid world of separate, autarchic, nuclear powers having very little to do with each other. . . . If you can 'standoff' every other nation in the world, there is not a pressing necessity to be connected with someone else who can do so, too [Burns, 1958, p. 38].

2.6.4 In that situation [when not only the Soviet Union, but also China has nuclear weapons] the condition of nuclear deterrence . . . would also in effect come to obtain within the Communist system [Modelski, 1960, p. 30].

2.6.5 Two limiting states of military art can be imagined which in the circumstance of the late twentieth century would come near to dictating policy: (1) the invention of a very cheap make-it-yourself, all-purpose deterrent would invite every nation to be isolationists in military affairs, fragmenting such alliances as NATO and the Warsaw Pact . . . (2) the opposite situation, in which an adequate deterrent weapon-system had become so expensive that only the superpowers or very large blocs could afford it. This second state of the art would almost prescribe a world alignment much like that which obtained, say, about 1956–58 [Burns, 1961, p. 188].

2.6.6 It has been argued that nuclear diffusion must prove destabilizing for the reason that nations acquiring nuclear weapons either would actually be in a more independent position than before or would at least feel that they enjoyed a greater degree of independence. According to this argument, nuclear diffusion may therefore be expected to have a disruptive effect on the cohesiveness and unity of the major alliance systems—particularly the Western alliance system [Tucker, 1962, p. 13].

2.6.7 The *n*th country would [not] continue to be as dependent on the support of its major nuclear ally, for the *n*th power's dependence on its major ally is obviously no more than a function of the pressures brought against it and the consequent insecurity it experiences. Given a diminution of those pressures, the dependence of the *n*th power is also bound to decrease [*ibid.*, p. 19].

2.6.8 Other things being equal, a coalition will be more stable to the extent that decision-making is centralized, i.e., the coalition is hierarchically organized [Snyder, 1961, p. 70].

As counterhypotheses the following propositions are offered:

2.6.9 A measure of independent [nuclear] strength for each of the NATO allies is likely to contribute to the cohesiveness of the alliance . . . [Hilsman, 1959, p. 168].

2.6.10 A nuclear arsenal under national control [is not] a means for becoming independent of big power tutelage. A major nuclear power, confronted by an *n*th country not backed by another major nuclear power, could always strike preemptively. Thus *n*th countries would continue to be dependent on the support of a major nuclear power [Kissinger, 1961, p. 242].

2.6.11 . . . within one bloc, the wider distribution of nuclear weapons poses great problems to the bloc: if the control over the weapons is unconditionally given to some of its members, the bloc is less firm as an entirety . . . nevertheless, the members will still be held together by common fears, ideals, interests, and treaties, the real force binding them is the existence of the superpower around which the bloc is formed . . . the fundamental tendency toward bipolarity will remain a characteristic of the power game [Morgenstern, 1960, pp. 206–8].

2.7 *The Feasibility or Likelihood of Nations Achieving an Independent Nuclear Capability*

There is relatively little in the unclassified literature on the question of the feasibility and likelihood of nuclear diffusion coming about. The National Planning Association (NPA), in two pamphlets on the subject (1958; 1960), estimates that between nine and sixteen nations will have nuclear weapons by 1970 if the present pattern of spread continues.

It is perhaps noteworthy that the NPA did not include Israel among those nations potentially capable of independently attaining nuclear weapons; yet stories of Israel's progress in this area were appearing within a year[2] of the publication of *The Nth-Country Problem* (NPA, 1960). Estimates of the status of China's nuclear development have also proven inaccurate. A few years ago "1961–1962" were the dates predicted for China to test a nuclear "device." The current estimates seem to favor "1964–1965." Experience with past predictions argues for caution in accepting estimates of who will gain nuclear weapons, when.[3]

Even if we were to feel certain about these estimates, questions about the level of capability attained would still remain. Thus, it is possible to agree with Paul Doty that "without international agreement and a display of national self-control uncommon to these times, admissions [to the "nuclear club"] will come with much greater frequency" (1960, p. 818). However, acceptance of the plausibility of this prophecy, which goes to emergence of nuclear nations rather than level of development, does not preclude agreement with General Giffin that:

> [In] the military matrix . . . postulated for the near future . . . there are only two great nuclear powers possessing very expensive and very complicated, but invulnerable, strike forces. Membership in this company could only be achieved by the control of enormous resources, including geography, hardly available to other powers for years to come [1962, p. 436].

General Giffin's prediction hinges on the qualifiers "expensive," "complicated," and "invulnerable"; other sophisticated weapons system characteristics, e.g., missile delivery, high warhead cost-effectiveness ratio, mobility, and positive command and control, will probably also be beyond the capability of all but the two "superpowers" in the near future.

But do these differences in the "state of the art" of weaponry make a difference? How crucial is level of development-sophistication to the predictions contained in the propositions in sections 2.4, 2.5, and 2.6?

It is hoped that the tools of analysis and measurement developed in this study of simulation worlds will be appropriate to examining these questions in the *real* world.

2.8 *The Approach to this Study*

The approach taken in this study stems from the assumption that to conceive of the "cold war" as a pattern of interaction is a useful heuristic. The "cold war" can be thought of as a system of action with certain describable regularities—interaction processes—which serve to define it as a steady state.

Proceeding from this heuristic, we may ask the following question: *If one characteristic of the "cold war" system—the number of nations with nuclear capability—is changed, will the system survive or will a new steady state emerge?*

Another way to ask the question is to query the cruciality of the nuclear capability differential within the blocs which comprise the "cold war" system. If the nuclear differential is crucial to the interaction pattern we call the "cold war," then we would expect that the spread of nuclear weapons

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[2] E.g., *New York Times*, December, 1960, p. 1.

[3] Some of our uncertainty on questions of feasibility and likelihood of spread taking place has been reduced by a book recently published on the topic (Beaton & Maddox, 1962).

(the *n*th-country situation) would alter the pattern of interaction.

The null hypothesis (H_0) is that this change will not materially change the state of the system. The experimental hypothesis (H_1) is that a marked change in the number of nuclear nations will be reflected in a marked (i.e., "step-level") change in the "cold war" system—a new steady state will result.

Figure 2.1 is a formal presentation of H_1. Herein, the formal properties which describe the "cold war" system are stated and linked and the predicted consequences of the experimental intervention—the induced increase in the number of nuclear nations—are set forth. This theoretical model was posited in advance of the experiments and forms the basis for the exploration reported in Chapter IV.

2.9 *A Model of the Cold War System*

In gross terms the "cold war" system can be described as "bipolar," i.e., there are two major centers of military and economic power toward which other nations are attracted. The reasons for attraction in a given direction would include historic and economic ties, fear of suzerainty being established by one superpower or the other, the actual presence of one or the other major power's troops at the end of World War II, and a feeling of being threatened by one or the other nuclear power.

Moreover, while nations exist outside of either alliance system, in many respects the bipolarity may be considered "tight." "At all times," according to Wolfers, "weak and vulnerable countries have sought refuge in neutrality and found it a source of protection, provided their stronger neighbors have held each other in check . . . the more American and Soviet power have come to balance each other, the greater the premium on neutrality" (1959, p. 10).

However, King indicates that, "the non-Communist alternative to membership in the United States collective defense network is not membership in a 'third force,' but neutralism, not the creation of another power center but the abnegation of power" (1959, p. 113).

Taken together, these propositions indicate that while nations may avoid alliance with either bloc, they do so at the price of reduced international influence, at least in the military sense. Given the absence of a third force, in many significant respects the future of the bipolarity becomes the future of the entire system. It should, therefore, not do violence to reality to consider the "cold war" system as tightly bipolar.

Between the blocs there has developed a state of high tension and, at least conceptually, antecedent to this tension are mutual perceptions of hostility. "Tension" can be defined as that behavioral state which is characterized by: (1) a focus of attention on an object, (2) where the object is charged with affect, and (3) where stereotypy and other processes of cognitive simplification characterize the assignment of meanings by members of one bloc vis-à-vis members of the other bloc (Milburn, 1961).

Where the object of focus is charged with negative affect—as is the case here, with hostility as the tension antecedent—behavior tends to take the forms of aggression and/or avoidance (Frank, 1958). Tension and hostility, thus, tend to reinforce each other.

This "tension-hostility" cycle feeds into inter-bloc relations. The process exhibits some of the characteristics of Newcomb's "autistic hostility cycle."

> Autistic hostility is . . . based upon a more or less fixed perception of self-other relation-

(N.B.: C1 indicates the *i*th condition in a chain of conditions which is hypothesized as being relevant in the transformation of a steady state A into another steady state B.)

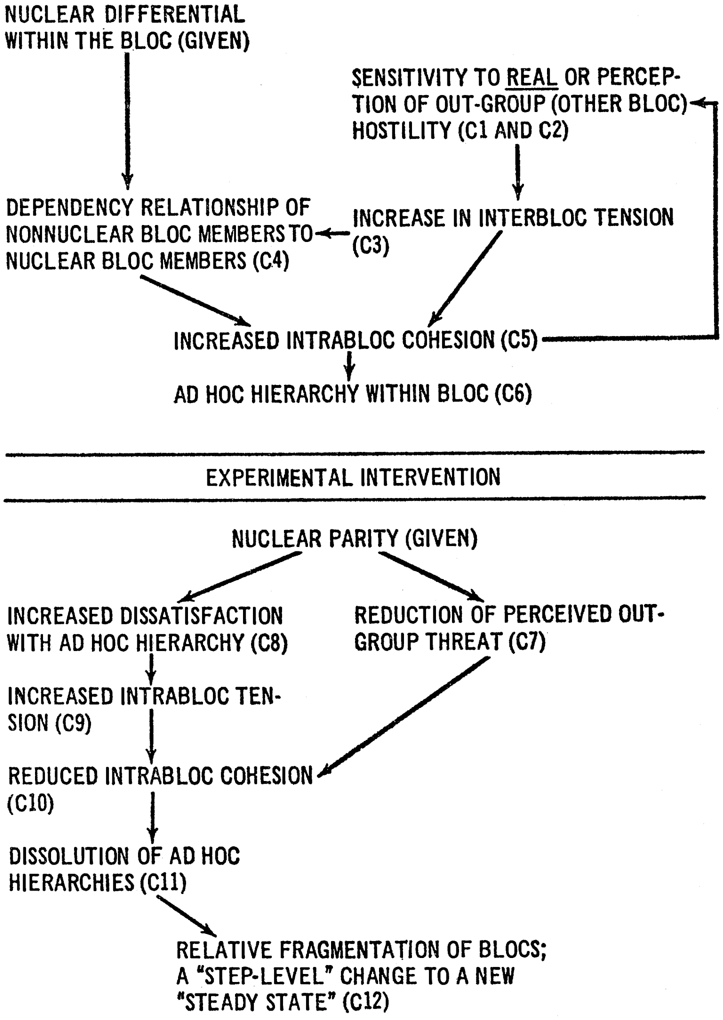
NUCLEAR DIFFERENTIAL WITHIN THE BLOC (GIVEN)
SENSITIVITY TO REAL OR PERCEPTION OF OUT-GROUP (OTHER BLOC) HOSTILITY (C1 AND C2)
DEPENDENCY RELATIONSHIP OF NONNUCLEAR BLOC MEMBERS TO NUCLEAR BLOC MEMBERS (C4)
INCREASE IN INTERBLOC TENSION (C3)
INCREASED INTRABLOC COHESION (C5)
AD HOC HIERARCHY WITHIN BLOC (C6)
EXPERIMENTAL INTERVENTION
NUCLEAR PARITY (GIVEN)
INCREASED DISSATISFACTION WITH AD HOC HIERARCHY (C8)
REDUCTION OF PERCEIVED OUT-GROUP THREAT (C7)
INCREASED INTRABLOC TENSION (C9)
REDUCED INTRABLOC COHESION (C10)
DISSOLUTION OF AD HOC HIERARCHIES (C11)
RELATIVE FRAGMENTATION OF BLOCS; A "STEP-LEVEL" CHANGE TO A NEW "STEADY STATE" (C12)

FIG. 2.1. Hypotheses linkings for INS-8.

ships, the persistence of which is maintained by barriers to communication (overt and/or covert) with the object of hostility [Newcomb, 1947, p. 73].

In other words, as hostility increases, communication decreases; as communication decreases, hostility increases.

The "tension-hostility" cycle also feeds into intra-bloc relations. The presence of perceived out-group hostility tends to reinforce the dependency relationship within the blocs and to increase intrabloc cohesiveness. The hostility becomes one aspect of a threat situation with which the nonnuclear bloc member feels inadequate to deal. This inadequacy leads to increased dependence on the nuclear armed bloc-leader.

This "dependency" also stems, in part, from the nuclear disparity between the "superpower" who heads the alliance and the other member nations. "The introduction of nuclear weapons," Wolfers asserts, "helped to tighten the bonds between [the United States and its European Allies]" (1959, p. 9). Miller indicates that, "their existence greatly increased . . . the interdependence of nations in the alliance" (1959, p. 37).

Morgenthau asserts that, "a nation will shun alliances if it believes it is strong enough to hold its own unaided" (1959, p. 185). By implication, if a nation believes that it cannot hold its own, it will be attracted toward membership in an alliance. Thus, the dependency born of perceived out-group hostility is increased by perceptions of military inadequacy vis-à-vis the hostile threatener. The attractiveness of bloc membership from this source also heightens intra-bloc cohesion—that is to say, cohesion varies positively with the attractiveness of group membership.

This within-bloc cohesiveness is itself a factor in exacerbating between-bloc hostility. The process operating here is described by Pepitone and Reichling as follows:

> Members of cohesive groups provide each other with strength and support, which enables them to overcome internal and external restraints against retaliation in the event of attack . . . highly cohesive groups . . . will be less restrained when under attack than will relatively less cohesive groups. The greater ability of highly cohesive groups to reduce restraints will be reflected . . . in a greater volume of expressed hostility and a more direct expression of hostility with respect to its source [1960, pp. 141–2].

The combination of dependence and cohesion has produced blocs which are more or less hierarchically organized. Hierarchical organization, in this context, indicates that "authoritative" decisions (i.e., those decisions which commit the bloc to a given international policy) tend to flow from the bloc-leader rather than from the other bloc members; in addition to yielding information about the locus of decision-making in the bloc, the hierarchy of organization yields predictions about the pattern of communication within the bloc. We would expect a hierarchical bloc to exhibit properties associated with a "wheel" communication net; we would expect that non-hierarchical blocs would have more or less "all-channel" communication nets.

In summary, the "cold war" system is composed of two hierarchically-organized bloc-alliances with the leading nations in the bloc possessing a virtual monopoly of nuclear strike and counter-strike capability. Moreover, there is tension-generating hostility between the blocs which reinforces cohesion within the blocs and which itself is reinforced by this cohesion. The relationship within the blocs is one of dependency, born of necessity. In part, the dependency relationship is due to the hostility of the nuclear armed leader of the opposing bloc and in part to the nuclear disparity within the alliance. It is in this context that the effects of the spread of nuclear weapons will be essayed and explored.

2.10 *The Cold War System and the Spread of Nuclear Weapons*

It has already been asserted—H_1—that the result of an increase in the number of nuclear nations, in the above-described system, will be a marked change in the "cold war" steady state. In this section, an attempt will be made to explicate the nature and direction of this change.

In two respects the relationship of each nation vis-à-vis its own alliance and toward the other alliance can be expected to be changed by the achievement of independent nuclear capability: (1) the reduction of the dependency on the bloc-leader, and (2) the reduction in the level of perceived out-group threat. Other changes in the system follow from these changes.

To illustrate the process of this change the following is offered.

"The Parable of the 97-lb. Weakling"

Doubtless we all remember the "Charles Atlas" ads which pictured the "97-lb. weakling" confronted by the bully on the beach. If we could have recorded the weakling's thoughts, they might have followed the following pattern:

"You are able to hurt me"; [the threat is credible]
"You appear to want to hurt me"; [he perceives hostile intent]
"You will hurt me if I can't stop you and I am unable to hurt you back"; [he feels that he hasn't the capability to deter]
"I can't stop you or hurt you back without help. Therefore, I'd better seek help—I'm willing to pay the cost of being allied."

At this moment, who should come along to save our weakling from his difficulty but Charles Atlas, himself. Atlas, in addition to forestalling attack by the bully, helps, either by example or actual instruction, the weakling build himself into a 210-lb. non-weakling, the equal of anyone around.

Now, when our hero comes upon the same bully, his thoughts might follow this pattern:

"You can hurt me";
"You appear to want to hurt me";
"But, I can now stop you because I can hurt you as much as you can hurt me; you don't like being hurt anymore than I do";
"I can now stop you without help. Therefore, I no longer need to pay the cost of being allied with Atlas."

This fantasy is designed to illustrate the hypothesis that only some aspects of a threatening interaction situation will be modified by increased capability. It will be noted that not all elements of the threat situation were changed by the attainment of independent capability by our former weakling. The potential aggressor's capability of inflicting damage remains intact. Moreover, the former weakling's perception of the "bully's" hostile intentions also are unchanged. But the credibility of the "bully's" aggressiveness is reduced as a function of the former weakling's felt capability to retaliate in kind. To this extent, the perception of threat is reduced.

Reduced also, it is hypothesized, is the willingness of the former weakling to remain part of an alliance which he feels no longer functions for his protection, at least to the extent of the costs involved in maintaining the alliance. Thus, the "parable" leads us back to Morgenthau's proposition: "A nation will shun alliances if it believes that it is strong enough to hold its own unaided or that the burden of the commitments resulting from the alliance is likely to outweigh the advantages to be expected" (1959, p. 185; Caplow, 1956; Gamson, 1959).

Another aspect of the "cold war" system can be expected to be affected by nuclear parity within the bloc—the hierarchical organization of the blocs. If, as has been asserted, a *raison d'être* for the acceptance of a hierarchical structure is the nuclear disparity, it should follow that the achievement of nuclear parity will raise questions about the equitability of that hierarchy (Prop. 2.6.7, above).

Moreover, if we accept with Lasswell that, other things being equal, power is a good index of participation in decision-making, then we would expect that as this (nuclear) base of power increases for the former nonnuclear bloc members, their willingness to remain in a subordinate decision-making role will decrease.

Miller was quoted above (Prop. 2.5.8) as asserting that "a nation may be attracted toward a nuclear development of its own

. . . not only because nuclear weapons mean power, honor, and a fuller sovereignty in general in our time, but also because in particular a nation so equipped can now itself make the key decision, to defend itself with these weapons and to pull its allies into the fight" (1959, p. 37). This decision (however significant) would probably be only one of many crucial decisions in which a new nuclear nation would be capable of exercising influence.

The capability of decisional independence and the increased unwillingness to remain subordinate in the bloc (i.e., increased dissatisfaction with the hierarchical structure of the bloc) will, it is hypothesized, lead to an increase in intra-bloc tension.

This hypothesis is consistent with Modelski's prediction about the effect of China's nuclear development on the "Communist international system." He asserts (Prop. 2.6.4, above), "in that situation [when Peoples' China also has nuclear weapons] the condition of nuclear deterrence, familiar from Soviet-American relations, would also in effect come to obtain within the Communist system" (1960, p. 30). When we add to China, Czechoslovakia, The German Democratic Republic, and Poland—the other Communist nations estimated by the NPA to be capable of having nuclear weapons by 1970—tension within the bloc should reach substantial levels.

Coupled with reduced perceived "out-group" threat, the increase in intra-bloc tension should lead to a marked reduction in the cohesion which previously characterized the bloc-alliance system (Prop. 2.6.6, above). The attractiveness of membership will be lessened, particularly membership under a hierarchical structure. The alliances may survive this traumatic input but they will not survive it unchanged.

Kaplan hypothesizes that "the less hierarchical in structure the bloc actors are, the more possible it becomes for national actors to dissociate themselves from the bloc and the more impetus there is in the direction of some sort of 'balance of power' system" (1957, p. 40).

In this model, the phrase "in the direction of some sort of balance of power system" has been translated into the word "fragmentation." The expected change is the fragmentation of the blocs (Prop. 2.6.5, above). Whether the steady state which emerges will look like Kaplan's "balance of power system" (1957, p. 30ff) or "unit veto system" (1957, p. 50ff) will depend on decisions which are occasioned by the spread. If national strike forces are maintained, the system will probably resemble the unit veto model. If, however, spread is followed by disarmament, the balance of power model will probably describe the system. In either case where there were two power centers there will now be multiple power centers (Prop. 2.6.3, above).

In summary, the expected change in the "cold war" system is the fragmentation of the blocs which comprise it. This (step-level) change will be prompted by the increased independence of the formerly non-nuclear national actors after they achieve nuclear capability; the increased sense of independence and a lowering of the perceived threat from the opposing bloc will lessen the intra-bloc cohesion and eventuate in the predicted fragmentation.

CHAPTER III

Simulation and the *n*th-country situation: research design

3.1 *Introduction*

The development of what it is hoped is a coherent, analytic model of the effects of the spread of nuclear weapons does not eliminate the problem of alternative formulations and mutually contradictory hypotheses. The problem of finding means for evaluating the plausibility of alternative formulations remains with us.

Deprived, as we are, of on-going, crucial, "natural" experiments we are left with the choice between waiting for the *n*th-country situation to evolve in actuality or working with the two extant, approximate cases—i.e., the British and French developments—or trying to artificially reproduce the "cold war" system and then experimentally inducing the spread of nuclear capability.

In the final analysis, the confirmation or disconfirmation of the model will depend upon the effects of nuclear diffusion in the *real* world; in this sense we have no choice but to wait for the situation to evolve. But if our interest is in evaluating the plausibility of the model *prior* to the actual occurrence, substitutes for a full-blown, crucial, natural experiment must be sought.

The two alternative approaches which are available—case studies of extant developments and simulation—are by no means mutually exclusive enterprises. The paucity of case material augurs ill for the exploration of the *n*th-country situation with any statistical model in mind.[1] But these cases can be productive of hypotheses and offer potential reality checks for ideas and measuring tools developed in the simulation.

Currently, studies of the British and French nuclear developments are underway. Harvey deWeerde, of RAND Corporation, has been engaged in intensive historical research on Britain's nuclear program. Ciro Zoppo, also of RAND Corporation, has produced an interesting paper on French efforts to develop the *force de frappe* (1962). The UCLA National Security Studies Program, under the direction of Richard Rosecrance, has been conducting a series of seminars on nuclear diffusion with emphasis on the British and French programs. None of these research efforts is completed; at their present stage of development, emphasis has been on the domestic political and economic processes which have shaped the emergence of nuclear capability in these two countries and on the military implications for the Western Alliance—the implications of these developments for the cohesiveness of the Western Alliance and its effects on the "cold war" have received less emphasis. Studies on these points are precisely what is needed if the model presented in Chapter II is to be confirmed or disconfirmed.

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[1] On the problems and benefits of using case materials, see Paige (1959).

With only two real world cases to draw upon—and both of these being in one bloc—at this time only suggestive evidence can be adduced for or against the model. Gaming, therefore, remains as a potentially useful approach.

The particular gaming approach employed—the Northwestern Inter-Nation Simulation (hereafter, INS)—was chosen because of the author's experience with this operating model and because it was felt that the INS was flexible enough to offer a reasonable prospect of providing a model world in which the spread of nuclear weapons could be examined.

3.2 *The Inter-Nation Simulation: A Brief Description*

Since detailed descriptions of the INS exist elsewhere, it would be redundant to present more than a synopsis here. For full-blown discussions and descriptions of the INS, the reader should see: Guetzkow (1959); Brody and Noel (1960); and Guetzkow, *et al.* (1963).

The INS is comprised of a group of groups, i.e., a system of interacting units, where the units are teams of individuals. The unit-actors are styled "nations." The individuals who act for the nation are its "decision-makers."

As a convenience, before entering a discussion of the interaction between nations, the "domestic" structure of a single nation will be explicated.

The nation in the INS is a system of roles. Some of these roles (the "decision-making" roles) are occupied by live individuals—the "participants" or "subjects"—the other roles (validation roles) exist only insofar as they provide a source of constraints on the freedom of action of the live decision-makers.

The internal organization of the nation is determined, in large measure, by the participants. The "Central Decision-Maker" (CDM) represents the chief-of-state and performs the executive function of government. He maintains his position by satisfying those who validate his office-holding. The "Internal Decision-Maker" (IDM) represents the director of the budget; he is economic advisor to the CDM and performs such other tasks as are assigned to him by the CDM. The "External Decision-Makers" (EDMx and EDMy) represent the foreign relations structure of the nation and perform the corresponding function. They are, as are the IDM and the "Decision-Maker with respect to Force" (DMF), dependent upon the CDM for their continuance in office. The DMF is the military advisor to the CDM; it is his responsibility to advise on matters of strategy, allocation of resources to force capability and defense. The division of labor among these decision-makers is a matter for the CDM to decide; the "cabinet" holds office at the pleasure of the CDM. Outside of the "government" is an aspiring Central Decision-Maker (CDMa) who represents the leadership of competing elites in the nation who aspire to become the group in power.

The number of participants who fill these roles will vary with the number of subjects available and the problem being studied. The six key roles are always represented but one participant may be called upon to perform more than one role, e.g., CDM and IDM. The CDMa role has often been represented symbolically (rather than by a participant); on these occasions the pressure exerted by the "opposition" becomes part of the over-all pressure exerted by the "validators" on the decision-makers. On only one occasion has the number of participants per nation been less than three; in that instance, two decision-makers per nation were used with a specific research purpose in mind (Hermann and Hermann, 1962).

The "validators" are conceptually the group or groups, within a nation, to whom decision-makers (especially the CDM) are responsive and responsible. The office-holding of the CDM (and, consequently, the office-holding of his "cabinet") is functionally related to the level of "satisfaction" of the validators. Since not all decision-makers (in real nations) are equally responsive and responsible to their validators, we have allowed the degree of relationship to vary in the simulation. This degree of relationship (termed "decision latitude") is expressed in terms of a ten-point scale—the higher the decision latitude, the less sensitive is the CDM's office-holding to the level of validator satisfaction.

Validator satisfaction stems from two basic sources: (1) from "consumption," i.e., from expenditure (by the CDM) for consumer goods and services *beyond* the minimum needed to sustain the population; and (2) from felt "national security," i.e., from the level of capability (military and economic) of the nation and its allies in comparison with its strongest nonally and that nation's allies.

Time, in the simulation, is expressed in terms of decision periods. A period (from 50–70 minutes of *real* time) is a unit of domestic, fiscal decision-making—other types of decisions are made more or less continuously and are unprogrammed with respect to game time.

At the beginning of a period, the CDM receives a "decision form." This form constitutes the CDM's primary source of information about his domestic, political-economic setting; on it are found the results of his previous period's decision-making. These "results" include data on validator satisfaction, the level of the nation's economy—expressed as "basic capability"—and the level of the nation's military strength—termed "force capability." The decision form also informs the CDM about the minimum amount of basic capability which must be allocated to generating consumer goods and services. Thus, the decision form gives the CDM basic information about the nature of his domestic environment at time "t_i"—information which is vital to his decision-making at time "t_{i+1}."

Emphasis, thus far in this synopsis, has been on the domestic setting of one (any one) nation in the INS; this emphasis is not inordinate. In the INS, in contradistinction to the other operating models presented in Chapter I, an effort has been made to represent the *domestic* constraints on the *foreign* policy-making process. These constraints are presented to the decision-maker as parametric values for a set of (hopefully) prototypic variables—public opinion, economic level, military level, decision latitude, and consumer demands.

By manipulating these parametric values at the outset of the simulation (i.e., time "t_0"), parallels to real world nations can be drawn. In this manner, role-playing of one sort (i.e., where the participant is charged with the responsibility of reproducing a "predicted" strategy for a nation which is not his own, but about which he knows a great deal) can be avoided. The participants in the INS are not instructed to "react the way the Soviet Union would react to the strategy of the United States"; rather, they are instructed to "react to the situation in which you find yourself." To further reduce pressure for this type of role-playing, nations in the INS are not given real world names. A set of imaginary nations (*viz.*, Algo, Erga, Ingo, Omne, and Utro) have been created, with characteristics which vary with the research problem under consideration.

Despite the emphasis on the domestic

constraints on decision-making, the INS is an operating model of the international system; prototypic classes of international behavior exist in the model. Thus, a nation may remain at peace or engage in war; moreover, wars may be limited or total; a nation may trade with other nations and seek or give foreign aid; alliances may be formed for a variety of reasons and with differing degrees of cohesion; international organizations may be founded or foundered. Several media of international communication are available: written messages, face-to-face conferences, international organization, and a "world press."

In general, in the INS, international interaction is less highly programmed than the domestic setting—in this arena participants are dealing with each other rather than with a conceptual reference group. Since the pattern of interaction is the primary locus of analysis, we have endeavored to leave the participants as free as possible to respond to and shape the international situation in which they find themselves.

3.3 *INS-8: Structuring the Basic Simulation to Admit the Exploration of the* Nth-*Country Situation*

In the "exploratory," "feasibility," and "classroom laboratory" runs of the simulation (runs INS-1 through INS-7) we adhered to our policy of nonintervention once the simulation was underway. These runs were invaluable in the development and 'shaking down' of the model (Guetzkow, *et al.*, 1963).

As a result of this experience, we felt that certain changes and restructuring of the basic system were required if the theoretical model of the "cold war" and the predicted effects of the spread of nuclear capability (presented in Chapter II) were to be given a fair test. The basic system so amended was dubbed "INS-8"—the eighth running of the INS. INS-8 was itself run seventeen times—i.e., seventeen iterations of the same starting situation with differing groups of decision-makers. These runs were designated INS-8-I through INS-8-XVII.

A detailed description of the emendation of the simulation, for this study, exists elsewhere (Guetzkow, *et al.*, 1960); a brief presentation here should be sufficient to give the reader a feel for INS-8.

For INS-8, it was decided that the theretofore usual number of nations (five) would not be sufficient; two new nations were added—Yora and Zena. We felt that the larger number of nations would give us a closer approximation to the real world system we were modeling and provide a more stable statistical base for the testing of hypotheses—for example, if we are testing a hypothesis about behavior in the dyad, in a five-nation system twenty such (nonsymmetric) dyads exist; by adding two nations we more than double ($N = 42$) the number of nonsymmetric dyads.

In three ways we increased the kinds of goods and services that could be generated by the allocation of basic capability: (1) force capability, which had been of one type only, was now differentiated into "nuclear" and "conventional"; (2) the nations were permitted to allocate basic capability to the "hardening"—i.e., passive defense against attack—of both nuclear force capability and basic capability; and (3) a procedure for conducting "research and development" projects was introduced. Plainly, these changes were dictated by the problem being considered.

The differentiation of force capability, into two types, was accomplished by developing two sets of "destruction ratios"—nuclear weapons are more effective than conventional weapons against certain targets—and by making nuclear capability more expensive to produce; i.e., it takes more basic capability to produce one unit of nuclear force capability than it does to produce one unit of conventional force capability.[2]

For the sake of realism, it was ruled that a nation's economy (i.e., absolute level of basic capability) would have to pass a size threshold before allocation to nuclear capability would be permitted; this threshold was set high enough to preclude attainment of this capability prior to the programmed experimental intervention.

The possibility of acquiring passive defense was introduced because of the emphasis it has received in the literature on deterrence strategy (e.g., Morgenstern, 1959; and Kahn, 1958). We made it possible for a CDM to achieve invulnerability for a portion of his nuclear force capability and to "dig in" or "harden" part of his basic capability (a feature analogous to civil defense). Both of these forms of passive defense are expensive—the defense of basic capability is decidedly more expensive than the defense of nuclear force capability.

The cost of defense notwithstanding, this provision made possible the adoption of strategies which reduce the pressures for preemption—we sought to provide decision-makers with a wide range of potential strategies.

The third change—the addition of research and development programs (R & D) —was prompted by two considerations: (1) the experimenters' desire to add a category of decision-making which had important domestic and international consequences (Rummel, 1961); and (2) the experimenters' need for a plausible "cover" for the experimental intervention. R & D was presented to the participants as follows:

> . . . . one of the decisions which aids economic growth is the decision to allocate basic resources to research and development. This decision is indicated on the Decision Form (BCrd decision, Decision Form, line 59) at the beginning of each period. A nation must have accumulated 2,000 BC's [units of basic capability] allocated to research and development before it can expect to receive any return. Both the amount of return and the time of return are to some extent uncertain. A nation will have to wait from two to four periods before a research and development project will begin to pay off; once payoff begins it will last for three periods. There is one chance in six that a project will fail; i.e., never pay off. Once payoff begins, the nation receives 14,000 BC's in the first period of payoff, 10,000 BC's in the second period, and 6,000 BC's in the third period; however, there is one chance in six that in a given payoff period these amounts will be reduced by half or lost entirely for that one period. Once a nation has received all the return from one 2,000 BC 'project' it may begin another research and development project which would operate in the same manner as the first project. *There is also a small probability that research and development will yield return in the form of nuclear force capability rather than BC's* [Brody and Noel, 1960, p. 14, emphasis added].

The italicized sentence was our cover for the programmed spread of nuclear capability. All nations had a R & D project underway at time "t_0"; this project yielded nuclear capability to the nonnuclear nations according to a schedule which will be presented below.

We decided, for INS-8, to have an international organization established at time "t_0." This decision has been explained as follows:

> In earlier work, the simulation's tendency to generate international organizations was great enough to obviate any need to start the system-run with a structured organization al-

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[2] For his assistance in developing these cost/effectiveness ratios on nuclear and conventional capability, we are grateful to Dr. Frank Bothwell, Center of Naval Analyses, Franklin Institute.

> ready in existence among the nations. However, considerable effort often was devoted by the nations to the development of an international organization, be it a political, military, and/or economic institution. Therefore, in an attempt to allow concentration upon the n-countries problem *per se*, the seventeen system-runs were initiated with an international organization already in existence. The charter of this 'IO' provided for universal membership with regular sessions of permanent representatives . . . [Guetzkow, *et al.*, 1960, p. 5].

The EDMy was the permanent delegate to the IO.

As was indicated above, roles for up to six participants are provided for in the simulation. To have filled all of these roles—one person per role—for multiple runs would have taken us far beyond our potential supply of subjects. Faced with a choice between more runs with fewer participants per nation and fewer runs with more participants per nation, we chose the former. Our experience has been that combining roles works—i.e., the functions embodied in these roles get performed.

We used three participants per nation—combining the CDM and IDM, and EDMx and DMF, and giving the EDMy the twin responsibilities of aiding the EDMx with foreign affairs and attending the IO as permanent delegate. With seven nations per run and seventeen runs accomplished, 357 subjects participated in INS-8.

3.4 *The Participants and Their Selection*[3]

The participants in INS-8 were 357 North Shore and Northern Chicago high school students (172 males and 185 females). Those who participated were chosen from 709 students tested by Driver during June and July, 1960.

"The crucial variable in both selecting subjects and assigning them to nations in the INS," according to Driver, "was generalized abstractness. The degree of abstractness was measured by a form of the Situational Interpretation Test [SIT] developed by Schroder and Hunt" (Driver, 1962, p. 36). The SIT score was used to identify the subjects' locations on a "concrete-abstract" dimension. From these results, the subjects were classified into three groups, *viz.*, "abstract" (Type IV), "concrete" (Type I), and "neutral" (Types II and III). The distribution of participants, so classified, was as follows: 122 "concrete," 122 "neutral," and 133 "abstract." Whenever possible, subjects from the same SIT category were grouped together in a nation. Care was taken to distribute nations, so composed, randomly over the seventeen runs (Guetzkow, *et al.*, 1960, pp. 16–7).

In addition to the SIT, Form 40-45 of the California F Scale was used as a selection instrument. The F Scale correlates with the SIT and was used by Driver to increase the polarization of "Type I" and "Type IV" subjects. The distribution of participants' scores on the F Scale is "single-peaked," $\overline{X} = 53.8$, $X_{0.50} = 54.5$, $s = 8.62$—the distribution appears normal.

The subjects were almost all high school juniors and seniors; the exceptions were the few participants who had just completed their high school training five weeks prior to the beginning of the INS-8 runs.

Data (from the schools) on I.Q. (unfortunately, not complete and not always drawn from comparable measuring instruments) indicate that our participants were "average" or "above average" on this variable.

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[3] Dr. Michael Driver, Educational Testing Service, assumed primary responsibility for the selection and assignment of participants—for this I am deeply grateful. For a detailed description of the selection and assignment process, see: Driver (1962), and Guetzkow, *et al.*, (1960).

The ages of the subjects ranged from 15–18. The average age was 16. As far as possible, nations and runs were populated with participants, so as to reduce error variance from these subject psycho-social characteristics.

Despite the degree of simplification, operating a nation in the INS is still a complex task—it has been suggested that operating an INS nation is a task of about the same order of complexity for the high school or college student as operating a real nation is for the more experienced adult decision-maker (Driver, 1962). It is impossible to assess the merit of this suggestion but it is an interesting idea—this complexity is a potential source of bewilderment to the subjects. To reduce potential bewilderment of the participants (and, consequently, the error variance deriving therefrom) a two-phase program of training in the mechanics of the INS was instituted. In the first phase, the basic operating documents of the INS (the Participants Manual, a handbook covering the details of one of the roles, and information about the starting situation, i.e., time "t_0") were mailed to the subject in advance of his participation. In addition, a one-hour, on-the-job, training period (phase two) was used to further orient the subjects to the operation of the simulation.

In this training, the seriousness of the enterprise was emphasized. The subjects' mastery of the mechanics, involvement, and sober approach to the experiment was altogether remarkable. As evident of this involvement and sobriety, the fact is offered that out of over 9,000 inter-nation messages content coded, less than one per cent were coded "extra system," i.e., contained material not pertinent to the simulation.

3.5 *Time "t_0": The Starting Situation for INS-8*

The starting situation was programmed to yield two bloc-alliances (one of three nations, the other of four) which were very nearly alike in their military and economic capacities. Only one nation in each bloc had nuclear force capability at the outset—these nations were also the major economic powers. Table 3.1 summarizes the starting parameters—all seventeen runs began in the same manner.

Table 3.2 presents the "generation rates" of the several nations for the production of goods and services. The generation rate is an expression of the ratio of units of a given commodity produced to a unit of basic

TABLE 3.1

BLOC-ALLIANCE STRUCTURE WITH INITIAL BASIC AND FORCE CAPABILITIES[a]

The Omne-Yora-Erga Bloc Capabilities				The Utro-Zena-Ingo-Algo Bloc Capabilities			
Nation	Basic	Force		Nation	Basic	Force	
		FCc	FCn			FCc	FCn
Omne	34,000	1,600	28	Utro	30,000	1,500	25
Yora	12,000	700	—	Zena	8,000	200	—
Erga	8,500	750	—	Ingo	9,000	800	—
				Algo	7,500	100	—
Total	54,000	3,050	28		54,500	2,600	25

[a] The "basic capability" of the nation (subsuming, as it does, resources, both physical and human) represents the nation's ability to produce all goods and services. The "conventional" (FCc) and "nuclear" (FCn) force capability of the nation represents its ability to mount military operations against other nations. All units in the simulation are arbitrary, reflecting only the relative position of one nation *vis-à-vis* another.

TABLE 3.2

GENERATION RATES[a]

Nation	Rate BC/BC	CS/BC	FCn/BC	FCc/BC
Algo	0.8	1.0	0.06	0.5
Erga	0.8	1.5	0.02	0.5
Ingo	0.9	1.0	0.02	1.5
Omne	1.0	1.5	0.08	2.0
Utro	1.0	1.5	0.08	2.0
Yora	0.9	1.0	0.06	1.5
Zena	0.8	1.5	0.02	0.5

[a] BC = basic capability unit.
CS = consumption satisfaction unit.
FCn = nuclear force capability unit.
FCc = conventional force capability unit.

capability allocated—it is thus a measure of the efficiency of production.

In the absence of a medium of exchange, the differential generation rates, between nations on the same commodity, permit barter-trade according to comparative advantages.

In addition to this information about the starting parameters, the participants were given information on the initial military-economic-diplomatic situation *via* the following "World Perspective" (this document was offered in lieu of a scenario):

> In the simulation world two nations are the dominant centers of power. Omne and Utro, in addition to being the only nuclear powers at this time, are also in possession of large amounts of BC's, that is, economic potential. The other five nations cluster about these power centers in two bloc-alliances; the two bloc-alliances are relatively equal in comparison with each other—neither enjoying a clear superiority in all areas of present position or growth potential. All nations have research and development projects underway which *if* they bear fruit will yield increased economic potential or, perhaps, nuclear force capability.
>
> The present positions of the nations represent the product of both internal growth and international trade. The principal trading partners have been Omne, Yora, and Erga, on the one hand, and Utro, Algo, Ingo, and Zena on the other; trade has not been exclusively among these groups but it has tended to follow these lines.
>
> The bloc-alliances—the nations of Omne, Yora, and Erga making up one bloc and Utro, Zena, Ingo, and Algo the other—are trade as well as military alliances; both are secured by formal treaty [Quoted in: Guetzkow, *et al.*, 1960, pp. 24–5].

In this manner, the participants learned of the situation in which they would begin to operate their nations—the situation which emerged from their decision-making beyond time "t_0" was of their own making. The "worlds" beyond time "t_0" were unstructured by the experimenters except for the experimental intervention (the effects of which the study was designed to determine).

3.6 *Data Sources*

In order to determine the effects of the experimental intervention, measures (i.e., operational definitions of the variables) needed to be constructed. These measures were drawn from two classes of data from INS-8: (1) system endogenous data; and (2) system exogenous data.

"System endogenous data" are those data which result from the operation of the simulation by the participants: decision forms, force utilization plans, messages, conference and IO transcripts, press releases, trade and aid transactions, treaties—in short, the totality of materials, generated by the decision-makers, which lend themselves to the diagnosis of system process from time "t_0" to time "t_i." These data have been used to aid in the production of the "history" of each of the seventeen runs of INS-8 (Brody, *et al.*, 1961). The use of endogenous data in the exploration of the model will be discussed at length below.

The "system exogenous data" were generated from the administration of a battery of "pencil and paper" instruments. At three points during the simulation—just prior to the experimental intervention, just after the experimental intervention, and during the final period—the participants were asked to complete each of three "Policy Planning Aids."

"Planning Aid #1," a multi-dimensional scaling instrument, was developed and used by Driver in his work on INS-8 (Driver, 1962). This instrument will enter into this study only insofar as Driver's results are drawn upon for confirmatory or disconfirmatory data.

"Planning Aid #2," a form of the "Semantic-Differential" (Osgood, *et al.*, 1957), was used to assess decision-makers' perceptions of the nations in the system. Data from the "Semantic-Differential" do not enter into the analyses which follow; subsequent analyses are planned.

"Planning Aid #3," a rating sheet consisting of five "Lickert Scales," was used to assess the attitudes of decision-makers toward the other nations in the system. The participants were asked to "rate the friendliness, trustworthiness, helpfulness, and cooperativeness of the other nations" and to express their perception of the likelihood of the other nation "becoming involved in a war" with their nation. This rating form appears as Appendix I.

3.7 *Content Analyses*[4]

Before essaying the laboratory exploration of the model, a further note on methodology is in order. Throughout the balance of this chapter, reference will be made to "Leary Content Processes"; since the content analysis approach of Timothy Leary (1957) has not been widely used in political science, communication should be facilitated if we spend a moment discussing it and its application to the data of INS-8.

Leary's research was designed to illuminate the effects of personality on interpersonal behavior. In order to accomplish this a system of classification of message content was developed (1957, pp. 63ff.). Leary reports that,

> [i]n surveying the list of more or less generic interpersonal trends, it became clear that they all had some reference to a power or affiliation factor. When dominance-submission was taken as the vertical axis and hostility-affection as the horizontal, all of the other generic interpersonal factors could be expressed as combinations of these four nodal points. The various types of nurturant behavior appeared to be blends of strong and affectionate orientations towards others. Distrustful behaviors seemed to blend hostility and weakness . . . [a] circular two-dimensional continuum of sixteen generic variables represented the optimal degree of refinement of interpersonal themes [1957, p. 64].

While Leary identifies "sixteen generic variables," his analyses are made on the basis of eight interpersonal processes: (1) managerial-autocratic; (2) competitive-narcissistic; (3) aggressive-sadistic; (4) rebellious-distrustful; (5) self-effacing-masochistic; (6) docile-dependent; (7) cooperative-overconventional; and (8) responsible-hypernormal (1957, p. 65).

These eight processes form a circular continuum whose octants represent content-theme clusters; the continuum is presented as Figure 3.1 (after Leary, 1957, p. 65).

The octants are labeled with a two-letter code which indicates the placement of the original sixteen variables.

Leary defines two scale-scores, "DOM" and "AFL," which are composites of primary and (weighted) secondary dimensions:

$$\mathrm{DOM} = \mathrm{AP} - \mathrm{HI} + 0.7\,(\mathrm{NO} + \mathrm{BC} - \mathrm{FG} - \mathrm{JK}) \qquad (3.1)$$

---

[4] In the work reported in this section, the assistance, aid, and comfort provided by Dr. George Wright (University of Cincinnati) were invaluable. The original impetus for this mode of analysis came from Wright.

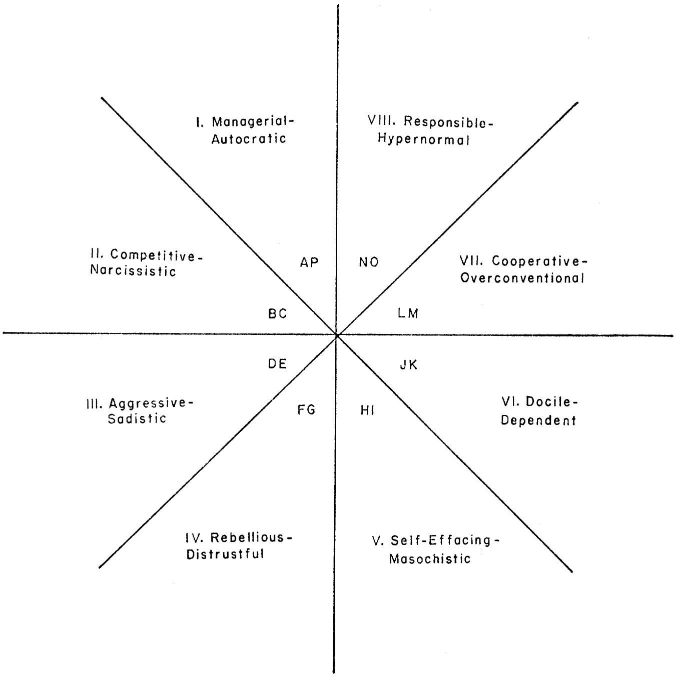
I. Managerial-Autocratic
VIII. Responsible-Hypernormal
II. Competitive-Narcissistic
AP
NO
VII. Cooperative-Overconventional
BC
LM
DE
JK
III. Aggressive-Sadistic
FG
HI
VI. Docile-Dependent
IV. Rebellious-Distrustful
V. Self-Effacing-Masochistic

FIG. 3.1 Leary octant processes.

$$\mathrm{AFL} = \mathrm{LM} - \mathrm{DE} + 0.7\ (\mathrm{NO} - \mathrm{BC} - \mathrm{FG} + \mathrm{JK}) \qquad (3.2)$$

Following Leary's logic, "dependency" (DEP) and "hostility" (HOS) scale-scores can be derived from the manipulation of simple trigonometric formulae:

The scale-score of the *i*th axis is defined as follows:

$$i\text{th axis score} = i - (1 + 180°) + 0.7\,[(i + 45°) + (i - 45°) - (i - 135°) - (i + 135°)] \qquad (3.3)$$

The scale-score of the $i + 90°$ axis is defined as follows:

$$i + 90° \text{ axis score} = (i + 90°) - (i - 90°) + 0.7\,[(i + 45°) - (i - 45°) - (i - 135°) + (i + 135°)] \qquad (3.4)$$

(In both formulae, $0.7 = \text{sine theta}$ [the angle made from moving counter-clockwise from the nearest boundary of the $i + 90°$ octant to the *i*th octant] $= \text{sine } 45°$.)

Thus, $\mathrm{DEP} = \mathrm{JK} - \mathrm{BC} + 0.7\ (\mathrm{HI} + \mathrm{LM} - \mathrm{AP} - \mathrm{DE})$; and (3.5)

$$\mathrm{HOS} = \mathrm{DE} - \mathrm{LM} - 0.7\ (\mathrm{NO} - \mathrm{BC} - \mathrm{FG} + \mathrm{JK}) \qquad (3.6)$$

Were they to be used, "trust," "suspicion," "submission," and "competition" scores could be derived in the same manner.

These labels (i.e., the Leary processes) it should be understood, are merely a shorthand for the complex of characteristic behavior (including communication behavior) in a given octant. Leary's identification of both "pathological" and "normal" (i.e., adaptive) content in each category proscribes a strictly pathological interpretation. The scale-scores profile the content of an individual's interaction with others and suggest the dominant loadings.

To apply this system of categorization to the analysis of approximately nine thousand inter-nation messages, the following steps were taken: (1) the unit of analysis was defined; (2) the operational specification of the content categories was accomplished; (3) the reliability of coding was determined; and (4) a decision was made on how to handle different levels of intensity. It should be noted that sampling problems did not emerge—all nine thousand messages were coded.

To extract maximum richness from this rich source of data, the transmitted message-form was chosen as the unit of analysis. However, if a transmitted message-form contained more than one theme, an appropriate number of codes was assigned to it. If, for example, both hostile and friendly themes were contained in a single message, both were coded (thereby indicating the ambivalence of the message).

We, of course, have no direct measure of the effect of the message—i.e., the degree to which nuance was picked up by the receiver—but the thrice given attitude scales seem to confirm the content analysis. For example, hostile communicators tend to be perceived as hostile; in correlating the receipt of hostile themes from a given nation with the rating of the hostility level of that nation by the nation receiving the communication, we find the following: $r_s = 0.53$; $t = 3.95$; $df = 40$; $p < 0.0005$.

We established the following scoring guide for each octant[5] (the principal process appears in all caps):

I. DOMINATING = AP
- The giving of orders without hostile overtones.
- Setting the terms of interaction.
- Giving suggestions or opinions which would induce the recipient to follow the sender's lead.
- Instruction.
- Direct request.
- Offer a deal such as a trade with a specific transaction suggested, e.g., such as specific amounts to be traded or a specific time for a conference.

II. REJECTION OR MANIPULATION = BC
- Self-praise in a manner derogatory or disparaging of others.
- Withholding, e.g., "I won't give in until you do," with a challenging quality.
- Aggressive confidence theme, e.g., "I don't need you to go ahead."
- Power struggle.
- Selfish motivation—self-centered.
- "Don't call us . . . we'll call you."

III. HOSTILE-AGGRESSIVE = DE
- Readiness to use power in aggressive manner—"either . . . or."
- Themes of punishment, threat, coercion, anger.
- Sarcasm.
- Ultimatum.
- Hard-hearted.
- Brutally frank.
- Impatient, in a hostile sense.
- Criticize.

IV. SUSPICIOUS = FG
- To be hurt, e.g., "You are doing bad things to me."
- Feelings of distrust, jealousy, scepticism, disappointment.
- Being rejected.
- Complaining.
- Resentful.

ANXIOUS-SUBMISSIVE = HI
- Feelings of personal discomfort, e.g., anxious, guilty, upset.
- Frightened.
- Inadequate, weak.
- Ambivalence, unable to commit self.
- Apologetic.
- Compliant (overly).

DEPENDENT = JK
- Provoking some kind of help or guidance.
- Asking for "aid" as opposed to "trade" among equals.
- Grateful, appreciative.

---

[5] The specification of these categories is primarily George Wright's work.

		Period											
		1	2	3	4	5	6	7	8	9	10	11	12
Algo	DF	-	x	x	x	x	x	x	x	x	x	x	x
	FCn's	-	no ---	-----	--- ▶	yes ---	-----	-----	-----	-----	-----	-----	--- ▶
Erga	DF	-	x	x	x	x	x	x	x	x	x	x	x
	FCn's	-	no ---	-----	-----	-----	▶ yes --	-----	-----	-----	-----	-----	--- ▶
Ingo	DF	-	x	x	x	x	x	x	x	x	x	x	x
	FCn's	-	no ---	-----	-----	-----	▶ yes -	-----	-----	-----	-----	-----	--- ▶
Omne	DF	Training	x	x	x	x	x	x	x	x	x	x	x
	FCn's		yes ---	-----	-----	-----	-----	-----	-----	-----	-----	-----	--- ▶
Utro	DF		x	x	x	x	x	x	x	x	x	x	x
	FCn's		yes ---	-----	-----	-----	-----	-----	-----	-----	-----	-----	--- ▶
Yora	DF	-	x	x	x	x	x	x	x	x	x	x	x
	FCn's	-	no ---	-----	-----	- ▶ yes	-----	-----	-----	-----	-----	-----	--- ▶
Zena	DF	-	x	x	x	x	x	x	x	x	x	x	x
	FCn's	-	no ---	-----	-----	---- ▶	yes ---	-----	-----	-----	-----	-----	--- ▶
IO meeting		-	ooo	ooo	ooo	ooo	ooo	ooo	ooo	ooo	ooo	ooo	ooo
Planning Aid		-			xxx			xxx					xxx

Legend:
DF = Decision Form.
FCn's = Presence of nuclear force capability (Note: Phase transition from bi-nuclear to n-nuclear.)
X = Time of arrival of DF to CDM (Note: The delivery of the DF's was staggered through the period but each CDM had his form in his possession the same length of time.)
ooo = Span of 30-minute IO meeting.
xxx = Time of administration of exogenous measures—30 minutes for each administration.

FIG. 3.2. Event flow in INS-8.

Demonstrates trust in someone stronger.
Eager to please.
Apple polishing.
"You set the terms of our interaction."
Asks a favor.
Asks for a loan.

VII. FRIENDLY-COOPERATIVE = LM

Proposes a trade among equals without the dominance implied in setting specific terms.
Proposes nonaggression pact for mutual benefit.
Going out of way to be nice, agreeable.
Anticipates happy ending.
Sharing, sharing information or confidence, e.g., about a third party.

VIII. SUPPORTIVE = NO

Support someone weaker.
Be very kind and gentle.
Think of other's welfare primarily.
Sympathy, understanding, soft-hearted.
Giving assurances.
Protect.
Give loans (even with interest).

In addition to the eight Leary categories, we felt a ninth (neutral) category was needed to accurately reflect the message content; 9 per cent of the coded themes was assigned to this category. This ninth category does not enter into subsequent analyses. However, its presence reduced the tendency to read one or another process into *all* themes during coding.

To check the reliability of coding, the messages from INS-8-I were double coded (by Wright and the author) and the codes compared (the messages from this system-run were also used to refine the eight categories)—the level of agreement (60 per cent; $N = 386$) was not considered high enough to justify the procedure of single coding the remaining sixteen system-runs. As a result of this reliability check, all messages were double coded and then randomly assigned to one or the other coder for reconciliation of differences. Checks on this reconciliation coding (*via* double reconciliation coding) yielded agreement over 90 per cent and this procedure, i.e., double coding and reconciliation coding by one or the other coder, was followed for system-runs INS-8-II through INS-8-XVII.

Leary observed that differing levels of intensity of expression affected the interaction of communicators; our experience in coding INS-8-I confirmed this observation. To account for intensity, we weighted coded themes—the expression of a given Leary Process was either coded as a single or double frequency depending on the intensity. Thus, for example, a rejective theme would be coded "II"; a very rejective theme would be coded "II+" and counted as double the frequency of occurrence.

Persistent doubts about the "interval" nature of the circular continuum and Leary's statement that, "while units around the scale are not equidistant, the arrangement is correctly ordered" (1957, p. 66), have militated for the selection of nonparametric statistical procedures where Leary Process Scores are involved. These procedures will be exclusively used in the analyses which follow.

3.8 *Event Flow in INS-8*

Before turning to the actual experiment and the testing of hypotheses, it is felt that "feel" for INS-8 can be enhanced by the presentation of a model of the flow of events in the simulation.

Each of the seventeen system-runs covered four half-days of real time—twelve periods of simulation time. In each case, the first period was given over to the on-the-job training discussed above. The decision-makers, therefore, received and completed eleven Decision Forms (the Period

12 Decision Form was completed but not returned to the decision-maker after calculation). The international organization met once each period—eleven times in all. The "pencil and paper" instruments were administered during Periods 4, 7, and 12. The experimental intervention was phased-in during Periods 5 and 6—our feeling was that a two period "transition" from binuclear to n-nuclear would aid in maintaining our cover story, i.e., seem less unnatural to the participants.

Figure 3.2 summarizes the flow of experimenter controlled events in INS-8.

CHAPTER IV

Simulation and the *n*th-country situation: exploration of the model

4.1 *Introduction*

In Chapter II, the attempt was made to present a set of linked conditions which serve to define the "cold war system" (Figure 2.1, above). These "conditions" and "linkages" are not rules of behavior for decision-makers, such as serve as defining characteristics of Kaplan's eight "systems" (1957); rather, they are a series of predictions about behavioral states which are hypothesized as typically emerging from the interactions of national-actors differentially structured with respect to their economies, military capabilities, and domestic political systems.

Chapter III dealt with the development of a laboratory setting in which this "island of theory" could be explored. Subjects were asked to make domestic and international decisions—i.e., to commit their nations to courses of action—in a bipolar, binuclear, seven-nation, simulation "world." Information about their domestic setting and international relationships was given to the participants prior to their participation. Information about the structure of the international system was kept to a minimum—the entire scenario was contained in a three-paragraph "World Perspective" (Section 3.5, above). The development of the nations and the international system beyond time "t_0" was almost entirely the product of the participants' decisions—the principal exception being the experimentally-introduced spread of nuclear weapons.

This chapter is devoted to the presentation of the results of the exploration of the theoretical model in the inter-nation simulation and the exploration begins with a basic question set.

4.2 *Fundamental Questions*

Drawing upon the hypotheses which appear in Chapter II, it seems reasonable to ask questions of the data generated in INS-8 at two levels of analysis—macro and micro.

The fundamental, macro-level question is: Is the international system different before and after the spread of nuclear weapons?

At a more micro-level, the following questions may be asked: If there is a change in the system, what is its relationship to the island of theory? That is to ask, is the "cold war system" established? Do we get two blocs which relate to each other and have an intra-bloc structure as predicted? Is the pre-spread system tightly bipolar? If the "cold war" does emerge, does it fragment under the impact of the spread of nuclear weapons?

It is necessary to answer the micro-level questions first, *via* the examination of the hypotheses contained in the theoretical model. The answer to the macro-level ques-

				Nation			
Nation	A	E	I	O	U	Y	Z
A		−	+	−	+	−	+
E	−		−	+	−	+	−
I	+	−		−	+	−	+
O	−	+	−		−	+	−
U	+	−	+	−		−	+
Y	−	+	−	+	−		−
Z	+	−	+	−	+	−	

+ = intra-bloc dyad; $N = 18$
− = inter-bloc dyad; $N = 24$

FIG. 4.1. Behavioral dyads in INS-8.

tion follows from this examination—the answer will serve as a summary evaluation of the model.

4.3 *Units of Analysis and the Pooling of Data*

Throughout the analyses which follow, the basic unit of analysis is the behavioral dyad aggregated over the system-runs. Two types of dyads—intra-bloc and inter-bloc—were defined (Figure 4.1). This definition is in terms of the alliances indicated to the participants in the "World Perspective."

Since the measurement of behavior for any pair of dyads composed of the same nations (e.g., AE and EA) is not expected to be symmetrical, our total number of dyads is forty-two.[1]

For several reasons it was considered desirable to aggregate over system-runs: (1) the effects of personality differences are reduced—because of Driver's design for subject placement, for any given nation, personality is randomly distributed over the seventeen system-runs; (2) aggregation over the runs provided more data in each of the dyads and increased the stability of the measures. To insure that aggregation was legitimate, various measures were checked for "poolability." "Runs test" (Siegel, 1956, pp. 52–8) performed on several measures yielded no systematic clusters within dyads, between "worlds." It was decided that an analysis of variance should be performed on at least one measure to double check the runs tests.

The cruciality of the measure of hostility (Systems Questionnaire, Scale #1, Appendix II) guided its selection. The scores were cast into a two-way table having k columns and N rows ($k = 17$; $N = 42$) reflecting the 42 dyad scores, on this measure, over the 17 system-runs. The scores were ranked within dyads across runs and a "Friedman Two-Way Analysis of Variance" (*ibid.*, 1956, pp. 166–72) was performed, with the following results.[2]

---

[1] This treatment is based on the assumption that the behavioral dyads are statistically independent of one another. "Statistical independence," in this context, means that a *score* (message frequency, rating, etc.) found in one dyad is unaffected by the *score* found in another dyad—in the same way, for example, that the appearance of a head or tail in one coin-flip is unaffected by the findings in previous flips. If the range of possible values for an event "e_2" is affected by the value of event "e_1," the events are said to be "not independent" (i.e., "correlated"). However, since the range of *values* for measures used to describe behavior or perception in one dyad is not affected by the *value* in another dyad, the scores will be treated as independent. This is not to argue that the behavior in the dyads is *psychologically* independent. The degree of psychological nonindependence resulting from different "treatment" (e.g., intra-bloc *vs.* inter-bloc) is precisely what the analyses which follow are designed to determine.

Null Hypothesis—H_0: There is no difference between replications on hostility-perception levels. H_1: There is a difference between replications.

$$\chi_r^2 = \frac{12}{Nk\,(k+1)} \sum_{j=1}^{k} (R_j)^2 - 3N(k+1);$$

where R_j is the sum of the ranks for the jth column (i.e., the jth replication).

$$N = 42;\ k = 17;\ \sum_{j=1}^{k} (R_j)^2 = 2{,}458{,}489.75;$$

$$df = 16;$$

thus,

$$\chi_r^2 = 0.00093\ (2{,}458{,}489.75) - 2{,}268$$
$$= 18.40;\ p = 0.30.$$

Decision—H_0 not rejected; the data are poolable.

4.4 *The Cold War System: Conditions and Linkages*

4.4.a PERCEPTION OF OUT-GROUP HOSTILITY

The first "condition" (C1, Figure 2.1, above) to be established in our exploration of the "cold war system" is the perception of the external bloc (i.e., the nations with whom a nation is not allied) as being hostile. The tendency of groups to distinguish "ins" and "outs" is pervasive and serves to bind aggregates of actors into a group (Campbell and LeVine, 1961). By extension, the presence of such distinctions should aid in binding aggregates of nations into bloc-alliances.

Null Hypothesis—H_0: perception of inter-bloc hostility is no greater than the perception of intra-bloc hostility. H_1: the inter-bloc dyads will rank higher on perceptions of hostility than will the intra-bloc dyads.

Statistical Test—Systems Questionnaire (Appendix I), Scale #1 is the measure of perceived hostility. On it, each of the seven nations rated the other six nations as to their "friendliness-unfriendliness"—high scores are toward the "unfriendly" end of the scale. The experimental hypothesis, in effect, predicts the relative rankings of perceptions across bloc lines in contrast with perceptions within the bloc. The "Mann-Whitney *U* Test" (Siegel, 1956, pp. 116 ff.) is appropriate for analyzing these data.

Significance Level—Let $\alpha = 0.05$ ($\alpha =$ probability of a Type I error). $n_1 = 18 =$ the number of intra-bloc dyads; $n_2 = 24 =$ the number of inter-bloc dyads.

Sampling Distribution—For $n_2 > 20$ the following formula yields values of z (*ibid.*, 1956, p. 123):

$$z = \frac{U - (n_1 n_2/2)}{\sqrt{(n_1)(n_2)(n_1 + n_2 + 1)/12}} \qquad (4.1)$$

The probabilities associated with occurrence under H_0 of values as extreme as an observed z may be determined by reference to a table of probabilities under the normal curve with zero mean and unit variance.

Rejection Region—Since H_1 predicts the direction of the differences, the region of rejection is one-tailed. It consists of all values of z which are so extreme that their associated probability under H_0 is equal to or less than $\alpha = 0.05$.

Decision—The hostility perception scores of each of the 42 dyads are shown in Table 4.1, together with the rank of each dyad.

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[2] The data upon which this analysis of variance is based are available at the Program of Graduate Training and Research in International Relations, Northwestern University, Evanston, Illinois.

TABLE 4.1

PERCEPTIONS OF INTER-BLOC AND INTRA-BLOC HOSTILITY

INTER-BLOC DYADS			INTRA-BLOC DYADS		
Dyad	Score	Rank	Dyad	Score	Rank
1. AE	230	27.5	1. AI	162	11
2. AO	229	26	2. AU	169	13
3. AY	234	29	3. AZ	178	18
4. EA	225	25	4. EO	134	2
5. EI	224	23.5	5. EY	149	7
6. EU	252	37	6. IA	160	10
7. EZ	239	33	7. IU	171	15
8. IE	224	23.5	8. IZ	165	12
9. IO	268	40	9. OE	151	8
10. IY	238	31.5	10. OY	142	5
11. OA	186	19	11. UA	177	17
12. OI	238	31.5	12. UI	139	3
13. OU	285	42	13. UZ	141	4
14. OZ	251	36	14. YE	144	6
15. UE	237	30	15. YO	124	1
16. UO	277	41	16. ZA	170	14
17. UY	259	39	17. ZI	173	16
18. YA	195	20	18. ZU	152	9
19. YI	222	22			
20. YU	246	35			$\Sigma = 171 = R_1$
21. YZ	242	34			
22. ZE	218	21			
23. ZO	254	38			
24. ZY	230	27.5			
		$\Sigma = 732 = R_2$			

For these data, $R_1 = 171$ and $R_2 = 732$. The value of U is found by substituting the observed values in the following formulae (*ibid.*, 1956, p. 120):

$$U = n_1 n_2 + \frac{n_2(n_2 + 1)}{2} - R_2 \qquad (4.2a)$$

or equivalently,

$$U = n_1 n_2 + \frac{n_1(n_1 + 1)}{2} - R_1. \qquad (4.2b)$$

From Formula 4.2a we find that:

$$U = 732 - R_2 = 0;$$

using Formula 4.1, we find:

$$z = U - 216/39.34 = 5.40.$$

Reference to the "Table of Probabilities Associated with Values as Extreme as Observed Values of z in the Normal Distribution" (*ibid.*, p. 247) reveals that $z = 5.40$ has a one-tailed probability under H_0 of $p < 0.00003$. Since the p is less than $\alpha = 0.05$, our decision is to reject H_0 in favor of H_1. *Nations in the external bloc are perceived as being more hostile than nations within the bloc.*

4.4.b TRANSMITTED EXPRESSED HOSTILITY

The second "condition" (C2, Figure 2.1, above) is the transmission of hostile messages between the blocs (i.e., "real" in contradistinction to "perceived" hostility).

Null Hypothesis—H_0: the transmission of hostility between the blocs is no greater than the transmission of hostility within the blocs. H_1: there is more hostility transmitted in inter-bloc dyads than in intra-bloc dyads.

Statistical Test—The HOS Leary Process Score (Formula 3.6, above) is the measure

TABLE 4.2

RECEIVED EXPRESSED HOSTILITY IN INTER- AND INTRA-BLOC COMMUNICATION

INTER-BLOC DYADS			INTRA-BLOC DYADS		
Dyad	Score	Rank	Dyad	Score	Rank
1. AE	-8.3	35.5	1. AI	-22.8	20
2. AO	-23.4	18	2. AU	-17.2	27
3. AY	-8.3	35.5	3. AZ	-15.8	30
4. EA	-10.3	32	4. EO	-65.4	2
5. EI	-10.8	31	5. EY	-43.4	7
6. EU	+0.4	42	6. IA	-26.8	16
7. EZ	-17.8	26	7. IU	-46.3	5
8. IE	-17.1	28.5	8. IZ	-23.1	19
9. IO	-8.5	34	9. OE	-63.2	3
10. IY	-20.9	23	10. OY	-18.9	25
11. OA	-19.0	24	11. UA	-27.5	15
12. OI	-26.5	17	12. UI	-40.3	9
13. OU	-57.2	4	13. UZ	-67.5	1
14. OZ	-28.3	13	14. YE	-44.3	6
15. UE	-8.6	33	15. YO	-38.7	10
16. UO	-27.7	14	16. ZA	-21.5	22
17. UY	-32.5	11	17. ZI	-31.9	12
18. YA	-6.3	38	18. ZU	-43.2	8
19. YI	-21.9	21			
20. YU	-17.1	28.5			$\Sigma = 237 = R_1$
21. YZ	-0.4	41			
22. ZE	-5.3	39			
23. ZO	-1.7	40			
24. ZY	-7.3	37			
		$\Sigma = 666 = R_2$			

of transmitted hostility. The hypothesis, in effect, predicts that more hostile themes will be contained in messages sent to members of the opposing bloc than will be contained in messages sent within the bloc. The U Test will be used in the analysis of these data.

Significance Level—Same as 4.4.a, above.

Sampling Distribution—Since $n_2 > 20$, Formula 4.1 will be used to determine z and the probability associated with the occurrence under H_0 of values as extreme as an observed z will be determined by reference to a table of normal probabilities.

Rejection Region—Same as 4.4.a, above.

Decision—The HOS Score for each of the 42 dyads is shown in Table 4.2, together with the rank of each dyad. For these data, $R_1 = 236$ and $R_2 = 667$. The value of U is found by substituting the observed values in Formula 4.2a:

$$U = 732 - R_2 = 66.$$

Using Formula 4.1, we find:

$$z = U - 216/39.34 = 3.81.$$

Reference to the table of normal probabilities (*ibid.*, p. 247) reveals that $z = 3.84$ has a one-tailed probability under H_0 of $p < 0.00007$. Since this p is less than $\alpha = 0.05$, our decision is to reject H_0 in favor of H_1. *More hostility is transmitted external to the bloc than internal to it.*

4.4.c THE PERCEPTION OF THREAT EXTERNAL TO THE BLOC

The third "condition" (C3, in Figure 2.1, above) is specified as "inter-bloc tension."

TABLE 4.3

PERCEPTIONS OF INTER-BLOC AND INTRA-BLOC THREAT

INTER-BLOC DYADS			INTRA-BLOC DYADS		
Dyad	Score	Rank	Dyad	Score	Rank
1. AE	206	29	1. AI	173	18
2. AO	243	36	2. AU	182	21
3. AY	197	25.5	3. AZ	156	15
4. EA	207	30.5	4. EO	149	12
5. EI	211	32	5. EY	144	9
6. EU	257	39	6. IA	146	10
7. EZ	207	30.5	7. IU	172	17
8. IE	198	27	8. IZ	152	14
9. IO	272	40	9. OE	136	6
10. IY	224	34	10. OY	141	8
11. OA	186	23	11. UA	174	19.5
12. OI	220	33	12. UI	148	11
13. OU	286	42	13. UZ	130	3.5
14. OZ	197	25.5	14. YE	116	2
15. UE	185	22	15. YO	136	6
16. UO	279	41	16. ZA	136	6
17. UY	236	35	17. ZI	114	1
18. YA	150	13	18. ZU	130	3.5
19. YI	189	24			
20. YU	246	37			$\Sigma = 182.5 = R_1$
21. YZ	169	16			
22. ZE	174	19.5			
23. ZO	252	38			
24. ZY	203	28			
		$\Sigma = 720.5 = R_2$			

Its inclusion was guided by the ubiquity of "tension" as a concept in the analysis of international relationships. However, attempts to meaningfully operationalize "tension" as an intervening variable proved futile—it is perhaps better left as a primitive used to describe a total interaction situation. Moreover, the presence of the concept "threat" in the post-spread model (C7, Figure 2.1, above) argued for its inclusion in the pre-spread analysis. Accordingly, "threat" will be substituted for "tension" in this analysis.

Null Hypothesis—H_0: the perception of threat across bloc lines is no greater than the perception of threat within the bloc. H_1: nations outside of the bloc will be seen as more threatening than nations within the bloc.

Statistical Test—Systems Questionnaire (Appendix I) Scale #2 is the measure of perceived threat. On it, each of the seven nations rated the other six nations on the "likelihood of becoming involved in a war" with the perceiving nation—high scores indicate a higher perceived likelihood. The hypothesis, in effect, predicts that nations outside of the bloc are seen as being more likely to become involved in a war with the rating nation than are the nations of the rating nation's own bloc. The *U* Test will be used in the analysis of the data.

Significance Level—Same as 4.4.a, above.

Sampling Distribution—Same as 4.4.a, above.

Rejection Region—Same as 4.4.a, above.

Decision—The threat perception for each of the 42 dyads is shown in Table 4.3, together with the rank of each dyad. For these data, $R_1 = 182.5$ and $R_2 = 720.5$. The value of U is found by substitution of the observed values into Formula 4.2a:

$$U = 732 - R_2 = 11.5;$$

using Formula 4.1, we find:

$$z = U - 216/39.34 = 5.20.$$

Reference to the table of normal probabilities (*ibid.*, p. 247) reveals that $z = 5.20$ has a one-tailed probability under H_0 of $p < 0.00003$. Since this p is less than $\alpha = 0.05$, our decision is to reject H_0 in favor of H_1. *There is a greater perception of threat from nations outside of the bloc than from nations within the bloc.*

4.4.d THE LINKAGE OF PERCEPTIONS OF HOSTILITY TO PERCEPTIONS OF THREAT

Figure 2.1 indicates a hypothesized link between hostility and tension (C1 → C3); the decision to trade "tension" for "threat" carries over to this aspect of the exploration of the model. Here, as will be the case with all the linkages examined, the use of discrete measures precludes establishment of antecedent-consequent (let alone, cause and effect) relationships. Measures of correlation are the best we can hope for; these should, however, when they are substantial, strengthen our confidence in the description of the "cold war" interaction system.

Null Hypothesis—H_0: hostility and threat are unrelated. H_1: there is a positive relationship between perceptions of threat and perceptions of hostility; i.e., as perceptions of hostility increase, perceptions of threat will also increase.

Statistical Test—The data in Tables 4.1 and 4.3 are the ranked measures of perceived hostility and perceived threat. The hypothesis, in effect, predicts a positive correlation between these measures. The Spearman Rank Order Correlation Coefficient (r_s) (*ibid.*, pp. 202 ff.) will be used to test this hypothesis.

Significance Level—Let $\alpha = 0.05$. $N = 42$ = the number of dyads ranked on these two measures.

Sampling Distribution—Since $N > 10$, the sampling distribution is distributed as Student's t with $df = N - 2$. The following formula is used to determine the value of t for given observed values of r_s (*ibid.*, p. 212):

$$t = r_s \sqrt{\frac{N-2}{1-(r_s)^2}} \qquad (4.3)$$

The probability associated with the occurrence under H_0 of values as extreme as an observed t will be determined by reference to the "Table of Critical Values of t" (*ibid.*, p. 248).

Rejection Region—Since H_1 predicts the direction of the correlation, the region of rejection is one-tailed. It consists of all values of t which are so extreme that their probability of occurrence under H_0 is equal to or less than $\alpha = 0.05$.

Decision—The rankings of each of the dyads on the two variables are shown in Table 4.4.

For these data, $\Sigma d^2 = 1{,}501.5$. The value of r_s is found by substituting the observed value into the following formula (*ibid.*, p. 206):

$$r_s = 1 - \frac{6 \Sigma d^2}{N^3 - N}. \qquad (4.4)$$

Thus, for these data,

$$r_s = 1 - \frac{6\ (1{,}501.5)}{74{,}046} = 0.88;$$

using Formula 4.3, we find:

$$t = 0.88\ (13.34) = 11.7.$$

Reference to the Table of Critical Values of t reveals that $t = 11.7$, with $df = 40$,

TABLE 4.4

CORRELATION OF PERCEIVED HOSTILITY AND PERCEIVED THREAT

Dyad	Hostility Rank	Threat Rank	d	d^2
1. AE	27.5	29	1.5	2.25
2. AO	26	36	10	100
3. AY	29	25.5	-3.5	12.25
4. EA	25	30.5	4.5	20.25
5. EI	23.5	32	8.5	72.25
6. EU	37	39	2	4
7. EZ	33	30.5	-2.5	6.25
8. IE	23.5	27	3.5	12.25
9. IO	40	40	0	0
10. IY	31.5	34	2.5	6.25
11. OA	19	23	4	16
12. OI	31.5	33	1.5	2.25
13. OU	42	42	0	0
14. OZ	36	25.5	-10.5	110.25
15. UE	30	22	-8	64
16. UO	41	41	0	0
17. UY	39	35	-4	16
18. YA	20	13	-7	49
19. YI	22	24	2	4
20. YU	35	37	2	4
21. YZ	34	16	-18	324
22. ZE	21	19.5	-1.5	2.25
23. ZO	38	38	0	0
24. ZY	27.5	28	0.5	0.25
25. AI	11	18	7	49
26. AU	13	21	8	64
27. AZ	18	15	-3	9
28. EO	2	12	10	100
29. EY	7	9	2	4
30. IA	10	10	0	0
31. IU	15	17	2	4
32. IZ	12	14	2	4
33. OE	8	6	-2	4
34. OY	5	8	3	9
35. UA	17	19.5	1.5	2.25
36. UI	3	11	8	64
37. UZ	4	3.5	-0.5	0.25
38. YE	6	2	-4	16
39. YO	1	6	5	25
40. ZA	14	6	-8	64
41. ZI	16	1	-15	225
42. ZU	9	3.5	-5.5	30.25
				$\Sigma d^2 = 1{,}501.5$

has a one-tailed probability under H_0 of $p < 0.0005$. Since this p is less than $\alpha = 0.05$, our decision is to reject H_0 in favor of H_1. *There is a positive relationship between perceptions of hostility and perceptions of threat.*

4.4.e THE LINKAGE OF RECEIVED EXPRESSED HOSTILITY AND PERCEPTIONS OF THREAT

The linkage of hostility to threat in Figure 2.1 (C2 → C3) implies a relationship of the receipt of hostile messages (or themes in messages) and the perception of threat; this implication was also investigated.

Null Hypothesis—H_0: the receipt of hostile messages is unrelated to perceptions of threat. H_1: there is a positive relationship between the receipt of expressed hostility and perceptions of threat.

Statistical Test—The data in Tables 4.2 and 4.3 are the ranked measures of received expressed hostility and perceptions of threat. The Spearman r_s will be used to test H_0.

Significance Level—Same as 4.4.d, above.

Sampling Distribution—Same as 4.4.d, above.

Rejection Region—Same as 4.4.d, above.

Decision—The rankings of each of the 42 dyads on the two variables are shown in Table 4.5. For these data, $\sum d^2 = 7{,}022.5$. The value of r_s is found by substitution into Formula 4.4:

$$r_s = 1 - \frac{6\ (7{,}022.5)}{74{,}046} = 0.43;$$

using Formula 4.3, we find:

$$t = 0.43\ (7.0) = 3.01.$$

Reference to the Table of Critical Values of t (*ibid.*, p. 248) reveals that $t = 3.01$ with $df = 40$ has a one-tailed probability under H_0 of $p < 0.005$. Since this p is less than $\alpha = 0.05$, our decision is to reject H_0 in favor of H_1. *There is a positive relationship between the receipt of expressed hostility and perceptions of threat.*

4.4.f EXPRESSION OF DEPENDENCY ON BLOC LEADER

The fourth "condition" (C4, Figure 2.1, above) is specified as the dependency of nonnuclear bloc members (i.e., Algo, Erga, Ingo, Yora, and Zena) on the nuclear members of the blocs (i.e., Omne and Utro). A national actor is considered "dependent" to the degree that it has goal needs which cannot be satisfied unilaterally. The concern here is with whom the dependent actor communicates his feelings of dependence, i.e., to whom he looks for aid in satisfying these goal needs.

Null Hypothesis—H_0: the expression of dependency themes in communication directed toward the nuclear bloc member is no greater than the expression of these themes in communication directed toward the nonnuclear members of the bloc. H_1: a greater level of dependency will appear in messages directed to the nuclear bloc members than to nonnuclear bloc members.

Statistical Test—The DEP Leary Process Score (Formula 3.5) is the measure of transmitted dependency. The hypothesis, in effect, predicts that communication directed to the bloc-leader (i.e., the nuclear member) will contain more dependency themes, i.e., have a higher DEP score, than communication directed toward other nonnuclear bloc members. The *U* Test will be used in the analysis of these data.

Significance Level—Let $\alpha = 0.05$, $n_2 = 13$ = the number of intra-bloc dyads where the nuclear member is not the receiver; $n_1 = 5$ = the number of intra-bloc dyads where the nuclear nation is the receiver.

Sampling Distribution—The probabilities associated with the occurrence under H_0 of values as small as an observed U for n_2 between 9 and 20 are found by using Siegel's "Table K" (1956, pp. 274 ff.) which provides the probability of given critical values of U.

Rejection Region—Since H_1 states the direction of the predicted difference, i.e., DEP Scores will be higher where the nuclear nation is involved in the intra-bloc communication, the region of rejection is one-tailed. It consists of all values of U which are so small that the probability as-

TABLE 4.5

Correlation of Received Expressed Hostility and Perceived Threat

Dyad	Hostility Rank	Threat Rank	*d*	d^2
1. AE	35.5	29	− 6.5	42.25
2. AO	18	36	18	324
3. AY	35.5	25.5	−10	100
4. EA	32	30.5	− 1.5	2.25
5. EI	31	32	1	1
6. EU	42	39	3	9
7. EZ	26	30.5	4.5	20.25
8. IE	28.5	27	− 1.5	2.25
9. IO	34	40	6	36
10. IY	23	34	11	121
11. OA	24	23	− 1	1
12. OI	17	33	16	256
13. OU	4	42	38	1,444
14. OZ	13	25.5	12.5	156.25
15. UE	33	22	−11	121
16. UO	15	41	26	676
17. UY	11	35	24	576
18. YA	38	13	−25	625
19. YI	21	24	3	9
20. YU	28.5	37	8.5	72.25
21. YZ	41	16	−25	625
22. ZE	39	19.5	−19.5	380.25
23. ZO	40	38	− 2	4
24. ZY	37	28	9	81
25. AI	20	18	− 2	4
26. AU	27	21	− 6	36
27. AZ	30	15	−15	225
28. EO	2	12	10	100
29. EY	7	9	2	4
30. IA	16	10	− 6	36
31. IU	5	17	12	144
32. IZ	19	14	− 5	25
33. OE	3	6	3	9
34. OY	25	8	−17	289
35. UA	14	19.5	5.5	30.25
36. UI	9	11	2	4
37. UZ	1	3.5	2.5	6.25
38. YE	6	2	− 4	16
39. YO	10	6	− 4	16
40. ZA	22	6	−16	256
41. ZI	12	1	−11	121
42. ZU	8	3.5	− 4.5	20.25
				$\Sigma\, d^2 = 7{,}022.5$

sociated with their occurrence under H_0 is equal to or less than $\alpha = 0.05$.

Decision—The DEP Score of each of the intra-bloc dyads is shown in Table 4.6, together with the rank of the dyad.

For these data, $R_2 = 104$ and $R_1 = 67$. The value of U is determined by substitution of the observed value into Formula 4.2:

$$U = 80 - R_1 = 13.$$

Reference to Siegel's "Table K" reveals that $U = 13$ ($n_1 = 5$; $n_2 = 13$) has a one-tailed

TABLE 4.6

DEPENDENCY THEMES IN INTRA-BLOC DYADIC COMMUNICATION

DYADS IN WHICH NUCLEAR NATION IS RECEIVER			DYADS IN WHICH NONNUCLEAR NATION IS RECEIVER		
Dyad	Score	Rank	Dyad	Score	Rank
1. AU	6.4	14.5	1. AI	−7.2	10
2. EO	45.2	18	2. AZ	−2.1	12
3. IU	6.4	14.5	3. EY	1.0	13
4. YO	−25.9	3	4. IA	−14.3	7
5. ZU	32.5	17	5. IZ	−8.2	9
			6. OE	−22.9	4
			7. OY	−34.3	1
			8. UA	−26.5	2
			9. UI	−16.5	6
			10. UZ	−17.9	5
			11. YE	6.8	16
			12. ZA	−8.4	8
			13. ZI	−3.4	11
		$\Sigma = 67 = R_1$			$\Sigma = 104 = R_2$

probability under H_0 of $p < 0.05$. Since this p is less than $\alpha = 0.05$, our decision is to reject H_0 in favor of H_1. *There is greater tendency for dependency themes to appear in messages directed to nuclear bloc members than to nonnuclear bloc members.*

4.4.g THE LINKAGE OF DEPENDENCY TO PERCEPTIONS OF THREAT

Figure 2.1 indicates a hypothesized link between the level of perceived threat and the level of dependency on the bloc-leader ($C3 \rightarrow C4$). The argument here is that threat reduction is a goal-need experienced by the nonnuclear nations which they cannot unilaterally satisfy; aid and assurances from the nuclear nation in their own bloc will help satisfy this need, therefore the dependency on the bloc leader.

Null Hypothesis—H_0: perceptions of the external nuclear armed bloc leader as threatening are unrelated to expressions of dependency directed toward the nuclear bloc leader of the nation's own bloc-alliance. H_1: the more threatening the nuclear leader of the external bloc is seen, the more dependency expressions will be directed toward the nuclear member of a nation's own bloc-alliance.

Statistical Test—The DEP Leary Process Scores (Table 4.6) for the nonnuclear nations directed toward the nuclear nation in their bloc (*viz.*, the following dyads: AU, EO, IY, YO, and ZU) is the measure of dependency. The nonnuclear nation's perception of threat (Table 4.3) from the external bloc leader (*viz.*, the following dyads: AO, EU, IO, YU, and ZO) is the measure of threat. The Spearman r_s will be used to test H_0.

Significance Level—Let $\alpha = 0.05$. $N = 5$ = the number of nations ranked on these two measures.

Sampling Distribution—Since N is less than 10, the sampling distribution is $1/N!$ and the "probability of occurrence under H_0 of any particular value of r_s is proportional to the number of permutations giving rise to that value" (*ibid.*, p. 210). Siegel's "Table P" (1956, p. 284) gives critical values for r_s for N less than 10.

Rejection Region—Since H_1 predicts the direction of the correlation, the region of rejection is one-tailed. It consists of all critical values of r_s for $N = 5$ which are so

TABLE 4.7

CORRELATION OF DEPENDENCY AND THREAT

Nonnuclear Nation	Rank on Perception of Threat from External Nuclear Power	Rank on Dependency on Bloc Leader	d	d^2
1. A	1	2.5	1.5	2.25
2. E	4	5.0	1.0	1.00
3. I	5	2.5	–2.5	6.25
4. Y	2	1.0	–1.0	1.00
5. Z	3	4.0	1.0	1.00
				$\Sigma\, d^2 = 11.50$

extreme that the probability of occurrence under H_0 is equal to or less than $\alpha = 0.05$.

Decision—The ranking of each nonnuclear nation, on the two variables, is shown in Table 4.7.

For these data, $\Sigma\, d^2 = 11.5$. The value of r_s is found by substituting the observed value into Formula 4.4:

$$r_s = 1 - \frac{6\ (11.5)}{120} = 0.43.$$

Reference to Siegel's "Table P" reveals that $r_s = 0.43$ ($N = 5$) has a one-tailed probability under H_0 of $p > 0.05$. Since this p is greater than $\alpha = 0.05$, our decision is to not reject H_0. *Dependent themes appear to increase with perceptions of threat (the correlation is in the right direction) but the relationship may very well be random.*

4.4.h HOSTILITY AND DEPENDENCY

The search for correlates of dependency led to the examination of a linkage not specified in Figure 2.1—the relationship of the receipt of HOS (hostile) themes from the external nuclear bloc leader and the transmission of DEP (dependency) themes to the nuclear power in the nonnuclear nation's own bloc. The hypothesized linkage predicts this relationship unmediated by perceptions of threat. However, since this hypothesis was not stated in advance of the running of the simulation, the formal presentation of the hypothesis will be eschewed.

Statistical Treatment—The HOS Leary Process Scores (Table 4.2) for the nuclear nations directed toward their nonnuclear, nonallies (*viz.*, the following dyads: OA, UE, OI, UY, and OZ) is the measure of hostility. The DEP Leary Process Scores (Table 4.6) for the nonnuclear nations directed toward the nuclear nation in their bloc (*viz.*, the following dyads: AU, EO, IU, YO, and ZU) is the measure of dependency. The Spearman r_s is the measure of correlation.

Results—The rankings of each of the nonnuclear nations on the two variables are shown in Table 4.8. For these data, $\Sigma\, d^2 = 3.5$. The value of r_s is determined by substitution of the observed value into Formula 4.4:

$$r_s = 1 - \frac{6\ (3.5)}{120} = 0.825.$$

For $N = 5$, this r_s enters the "region of doubt" (i.e., $0.10 > p > 0.05$) and is worth investigating in the *real* world. *Dependent themes appear to increase with increases in the receipt of hostile themes from the external nuclear power but the relationship may be random.*

4.4.i THE COHESION OF THE BLOCS

The concept of "cohesion" (C5, Figure 2.1) has enjoyed a somewhat checkered career in group psychology. It tends to have an elusive quality about it; definitions

TABLE 4.8

CORRELATION OF DEPENDENCY AND HOSTILITY

Nonnuclear Nation	Rank on Receipt of HOS from External Nuclear Power	Rank on DEP Directed toward Internal Nuclear Power	d	d^2
1. A	1	2.5	1.5	2.25
2. E	5	5.0	0.0	0.00
3. I	3	2.5	–0.5	0.25
4. Y	2	1.0	–1.0	1.00
5. Z	4	4.0	0.0	0.00
				$\Sigma d^2 = 3.50$

of "cohesion" leave something to be desired from the point of view of operationalization: "Cohesiveness is the attraction of membership in a group for its members" (Back, 1951, p. 9) or, more general, "The cohesiveness of a group is the resultant of all forces acting on all members to remain in the group" (Cartwright and Zander, 1960, p. 74).

These caveats notwithstanding, two themes continually recur in the literature on cohesion: cohesion is related to uniformity of opinion and to communication frequency.

Two consistent findings in organizational and group research can aid in specifying measures of cohesion. These findings are reported by March and Simon: (1) "The greater the cohesiveness of a group, the greater the uniformity of opinion. . . . (2) The interaction of the group increases as group cohesiveness increases" (1958, p. 60).

It has already been shown that there is a high degree of uniformity of opinion within the bloc with respect to the hostility and threatening nature of the external bloc (Sections 4.4.a and 4.4.c, above); the level of interaction is our second measure of cohesion.

Null Hypothesis—H_0: communication frequency within the bloc is no greater than communication frequency between the blocs. H_1: the interaction between bloc members (i.e., communication frequency in intra-bloc dyads) will be greater than the interaction across bloc lines.

Statistical Test—The frequency of messages between dyadic communication partners is the measure of interaction. The U Test will be used to test the experimental hypothesis.

Significance Level—Same as 4.4.a, above.

Sampling Distribution—Same as 4.4.a, above.

Rejection Region—Same as 4.4.a, above.

Decision—The frequency of communication for each of the 42 dyads is shown in Table 4.9, together with the rank of each dyad.

For these data, $R_1 = 551$ and $R_2 = 352$. The value of U is found by substitution of the observed value into Formula 4.2a:

$$U = 732 - R_2 = 380;$$

from Formula 4.1, we find:

$$z = U - 216/39.34 = 4.17.$$

Reference to the Table of Normal Probabilities (Siegel, 1956, p. 274) reveals that $z = 4.17$ has a one-tailed probability under H_0 of $p < 0.00003$. Since this p is less than $\alpha = 0.05$, our decision is to reject H_0 in favor of H_1. *There is more interaction within the blocs than between the blocs—the blocs are highly cohesive units.*

TABLE 4.9

MESSAGE FREQUENCY IN INTER- AND INTRA-BLOC DYADS

Inter-bloc Dyads			Intra-bloc Dyads		
Dyad	Frequency	Rank	Dyad	Frequency	Rank
1. AE	33	3	1. AI	68	17.5
2. AO	99	30	2. AU	130	37
3. AY	34	4	3. AZ	69	19
4. EA	43	8.5	4. EO	161	41
5. EI	58	14.5	5. EY	94	29
6. EU	71	23	6. IA	80	26
7. EZ	41	7	7. IU	122	36
8. IE	50	12	8. IZ	73	24
9. IO	70	21	9. OE	136	38.5
10. IY	59	16	10. OY	136	38.5
11. OA	85	27	11. UA	107	32
12. OI	58	14.5	12. UI	103	31
13. OU	121	35	13. UZ	111	33
14. OZ	37	5	14. YE	91	28
15. UE	46	10.5	15. YO	163	42
16. UO	117	34	16. ZA	68	17.5
17. UY	53	13	17. ZI	70	21
18. YA	43	8.5	18. ZU	154	40
19. YI	79	25			$\Sigma = 551 = R_1$
20. YU	70	21			
21. YZ	31	2			
22. ZE	39	6			
23. ZO	46	10.5			
24. ZY	24	1			
		$\Sigma = 352 = R_2$			

4.4.j THE LINKAGE OF COHESION AND THREAT

Figure 2.1 indicates a link between perceived external threat and intra-bloc cohesion (C3 → C5); this is one aspect of the familiar "out-group" hypothesis.

Null Hypothesis—H_0: there is no relationship between perceptions of threat and levels of interaction (the measure of cohesion). H_1: the higher the level of perceived threat, the lower the level of interaction (a negative relationship).

Statistical Test—Tables 4.3 and 4.9 provide ranked measures of perceived threat and level of interaction. The Spearman r_s will be used to test this hypothesis.

Significance Level—Same as 4.4.d, above.

Sampling Distribution—Same as 4.4.d, above.

Rejection Region—Same as 4.4.d, above.

Decision—The rankings of each of the dyads, on the two variables, are shown in Table 4.10.

For these data, $\Sigma d^2 = 16{,}796$. The value of r_s is determined by substitution of the observed value into Formula 4.4:

$$r_s = 1 - \frac{6\,(16{,}796)}{74{,}046} = -0.36;$$

using Formula 4.3, we find:

$$t = -0.36\,(6.78) = -2.44.$$

Reference to the "Table of Critical Values of t" (*ibid.*, p. 248) reveals that $t = 2.44$ with $df = 40$ has a one-tailed probability under H_0 of $p < 0.01$. Since this p is less than $\alpha = 0.05$, our decision is to reject H_0 in favor of H_1. *There is a negative relationship between perceptions of threat and level of interaction.*

TABLE 4.10

CORRELATION OF THREAT AND COHESION

Dyad	Threat Rank	Cohesion Rank	d	d^2
1. AE	29	3	–26	676
2. AO	36	30	– 6	36
3. AY	25.5	4	–21.5	462.25
4. EA	30.5	8.5	–22	484
5. EI	32	14.5	–17.5	306.25
6. EU	39	23	–16	256
7. EZ	30.5	7	–23.5	552.25
8. IE	27	12	–15	225
9. IO	40	21	–19	361
10. IY	34	16	–18	324
11. OA	23	27	4	16
12. OI	33	14.5	–18.5	342.25
13. OU	42	35	– 7	49
14. OZ	25.5	5	–20.5	420.25
15. UE	22	10.5	–11.5	132.25
16. UO	41	34	– 7	49
17. UY	35	13	–22	484
18. YA	13	8.5	– 4.5	20.25
19. YI	24	25	1	1
20. YU	37	21	–16	256
21. YZ	16	2	–14	196
22. ZE	19.5	6	–13.5	182.25
23. ZO	38	10.5	–27.5	756.25
24. ZY	28	1	–27	729
25. AI	18	17.5	– 0.5	0.25
26. AU	21	37	16	256
27. AZ	15	19	4	16
28. EO	12	41	29	841
29. EY	9	29	20	400
30. IA	10	26	16	256
31. IU	17	36	19	361
32. IZ	14	24	10	100
33. OE	6	38.5	32.5	1,056.25
34. OY	8	38.5	30.5	930.25
35. UA	19.5	32	12.5	156.25
36. UI	11	31	20	400
37. UZ	3.5	33	29.5	870.25
38. YE	2	28	26	676
39. YO	6	42	36	1,296
40. ZA	6	17.5	11.5	132.25
41. ZI	1	21	20	400
42. ZU	3.5	40	36.5	1,332.25
				$\Sigma d^2 = 16{,}796.0$

4.4.k THE RELATIONSHIP OF DEPENDENCY TO COHESION

Figure 2.1 indicated a hypothesized link between expressions of dependency and cohesion ($C4 \rightarrow C5$).

Null Hypothesis—H_0: cohesion and dependency are unrelated. H_1: dependency and cohesion are positively related.

Statistical Test—Since the DEP Leary Process Score is to some extent relative to the frequency of communication, it cannot meaningfully be correlated with our measure of cohesion (communication frequency). As a substitute measure of cohesion, the

TABLE 4.11

CORRELATION OF DEPENDENCY AND AFFILIATION

Nonnuclear Nation	Rank on DEP Directed to Nuclear Member	Rank on AFL Directed to Nuclear Member	d	d^2
1. A	2.5	1	-1.5	2.25
2. E	5.0	5	0.0	0.00
3. I	2.5	4	1.5	2.25
4. Y	1.0	2	1.0	1.00
5. Z	4.0	3	-1.0	1.00
				$\Sigma\, d^2 = 6.50$

Leary AFL Process Score (Formula 3.2) was chosen—the AFL score is a measure of the affiliative themes contained in messages. The Spearman r_s will be used to determine the relationship between these two variables.

Significance Level—Let $\alpha = 0.05$. $N = 5$ = the number of nonnuclear—dependent—nations ranked on these two measures.

Sampling Distribution—Same as 4.4.g, above.

Rejection Region—Same as 4.4.g, above.

Decision—The rankings of each of the nonnuclear nations, on the two variables, are shown in Table 4.11.

For these data, $\Sigma\, d^2 = 6.5$, the value of r_s is found by substitution of the observed value into Formula 4.4:

$$r_s = 1 - \frac{6\ (6.5)}{120} = 0.675.$$

Reference to the "Table of Critical Values of r_s" (*ibid.*, p. 284) reveals that $r_s = 0.675$, $N = 5$, has a one-tailed probability under H_0 of $p > 0.05$. Since this p is greater than $\alpha = 0.05$, our decision is to not reject H_0. *Dependent themes appear to be related to affiliation themes (the correlation is in the right direction) but the relationship may be random.*

4.4.1 HIERARCHICAL ORDERING OF THE BLOCS

The sixth "condition" (C6) is specified in Figure 2.1 as the hierarchical ordering of the blocs. A sytsem is "hierarchical" to the degree that operationally differentiable

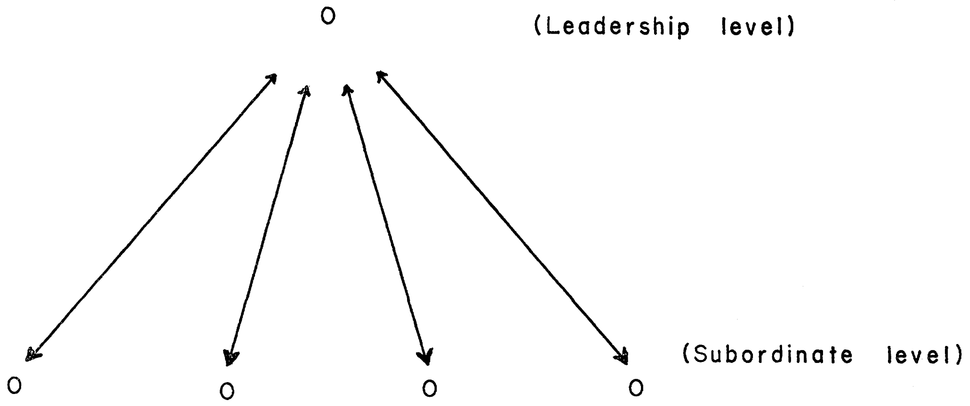

FIG. 4.2. Communication pattern in wheel structures.

"leaders" and "subordinates" can be distinguished. The small group literature identifies "leaders" as distributors in their information networks, i.e., leaders tend to receive and initiate more communication than do subordinates (Bavelas, 1950; Bales, *et al.*, 1951).

The communication pattern associated with this leader/subordinate system is the "wheel" (Figure 4.2, after Guetzkow and Simon, 1955, p. 237). Guetzkow and Simon call this wheel pattern a "two-level hierarchy." Arnold Wolfers has described the communication pattern in the Soviet and American alliances as "wheel-like" (1959, p. 7). The flow of communication along the dyadic channels, within the bloc-alliances, will be used as our operational measure of hierarchy.[3]

Null Hypothesis—H_0: there is no difference between the frequency of communication directed toward and initiated by the nuclear nations in the blocs and the frequency of communication directed toward and initiated by the nonnuclear nations in the blocs. H_1: the nuclear nations will receive and initiate more communication than the nonnuclear nations.

Statistical Test — Communication frequencies in the intra-bloc dyads (Table 4.9) is the necessary measure; the comparison will be made between intra-bloc dyads where the nuclear nations are one of the parties to the communication and intra-bloc where they are not involved in the communication. The *U* Test will be used in the exploration of this hypothesis.

Significance Level—Let $\alpha = 0.05$. $n_1 = 8 =$ the number of intra-bloc dyads in which the nuclear nation is not a party to the communication; $n_2 = 10 =$ the number of intra-bloc dyads in which the nuclear nation is a party to the communication.

Sampling Distribution—Same as 4.4.f, above.

Rejection Region—Same as 4.4.f, above.

Decision—The frequency of communication for each dyad is shown in Table 4.12, together with the rank of the dyad.

For these data, $R_1 = 36$ and $R_2 = 135$. The value of *U* is found by substitution of the observed value into Formula 4.2.a:

$$U = 135 - R_2 = 0.$$

Reference to Siegel's "Table K" (1956, p. 274) reveals that $U = 0$, $n_1 = 8$; $n_2 = 10$ has a one-tailed probability under H_0 of $p < 0.001$. Since this p is less than $\alpha = 0.05$, our decision is to reject H_0 in favor of H_1. *The nuclear members act as distributors in their communication nets; the nets exhibit the properties of the wheel structure—a two-level hierarchy.*

4.4.m THE TIGHTNESS OF THE BIPOLARITY

One question remains concerning the communication structure and, consequently, the international system prior to the spread of nuclear capability: How marked is the

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[3] It should be noted that in several of the analyses which follow, communication flow is used as the operational measure of what appear to be three different variables (*viz.*, "cohesion," "hierarchy," and "tightness of bipolarity"). My contention is that these are but different aspects of the same factor; namely, modal loci of interaction. When the level of analysis is at the total system level, i.e., inter-bloc *vs.* intra-bloc, we speak of interaction as a measure of the cohesiveness of the blocs. When the level of analysis is at the bloc-alliance level, the modal interaction pattern can be used to identify a bloc leader (if one emerges), in terms of his location in a communication net. When a nation has been identified as a "leader" in one bloc and we investigate the possibility of its being undifferentiated from the "leader" of the other bloc, we are using modal interaction pattern as a measure of the tightness of the bipolarity.

TABLE 4.12

COMMUNICATION FREQUENCY IN INTRA-BLOC DYADS

Dyads which Involve Nuclear Nation	Communication f	Rank	Dyads which Do not Involve Nuclear Nation	Communication f	Rank
1. AU	130	13	1. AI	68	1.5
2. UA	107	10	2. AZ	69	3
3. EO	161	17	3. EY	94	8
4. OE	136	14.5	4. IA	80	6
5. IU	122	12	5. IZ	73	5
6. UI	103	9	6. YE	91	7
7. YO	163	18	7. ZA	68	1.5
8. OY	136	14.5	8. ZI	70	4
9. ZU	154	16			
10. UZ	111	11			$\Sigma = 36 = R_1$
		$\Sigma = 135 = R_2$			

preference for communicating to the leader of the nation's *own* bloc?

It can be argued that since economic differentials also characterize the distinction between nuclear and nonnuclear nations (Table 3.1, above), the preference for communicating with Omne and Utro may only reflect the search for economic aid and not for military assistance. If this is the case, we would expect that tendencies for communicating exclusively with the nation's own bloc leader would not emerge. From the point of view of their ability to tender economic aid, there is no distinction between Omne and Utro; both have the same economic potential and started at the same economic level (Tables 3.2 and 3.1, respectively).

If a clear preference for communicating with the internal bloc leader does emerge, it would seem justified to argue that the hierarchies are based on more than economic differential and that a "tight" bipolar system emerged in the binuclear periods of INS-8.

Null Hypothesis—H_0: nonnuclear nations have no clear preference for the nuclear nation with which they communicate. H_1: the nonnuclear nations will exhibit a tendency to communicate with the leader of their own blocs (i.e., AU, EO, IU, YO, and ZU).

Statistical Test—Communication frequency (Table 4.9), of nonnuclear nations directed toward the nuclear nations, is the needed measure. Comparison will be made of communication within the bloc with communication across bloc lines. The *U* Test will be used to test this hypothesis.

Significance Level—Let $\alpha = 0.05$. $n_1 = 5 =$ the number of inter-bloc dyads in which the nuclear nation is receiver; $n_2 = 5 =$ the number of intra-bloc dyads in which the nuclear nation is receiver.

Sampling Distribution—The probabilities associated with the occurrence under H_0 of values as small as an observed *U* for n_1, n_2 less than or equal to 8, are given in Siegel's "Table J" (1956, p. 271).

Rejection Region—Since H_1 states the direction of the predicted difference, the region of rejection is one-tailed. It consists of all values of *U* which are so small that the probability of their occurrence under H_0 is equal to or less than $\alpha = 0.05$.

Decision—The frequency of communication for each dyad is shown in Table 4.13, together with the rank of the dyad.

TABLE 4.13

COMMUNICATION FREQUENCY OF NONNUCLEAR NATIONS WITH NUCLEAR NATIONS

Inter-bloc Dyads	f	Rank	Intra-bloc Dyads	f	Rank
1. AO	99	5	1. AU	130	7
2. EU	71	4	2. EO	161	9
3. IO	70	2.5	3. IU	122	6
4. YU	70	2.5	4. YO	163	10
5. ZO	46	1	5. ZU	154	8
		$\Sigma = 15 = R_1$			$\Sigma = 40 = R_2$

For these data, $R_1 = 15$ and $R_2 = 40$. The value of U is determined by substitution of the observed value into Formula 4.2a:

$$U = 40 - R_2 = 0.$$

Reference to Siegel's "Table J" (1956, p. 271) reveals that $U = 0$ ($n_1 = 5$; $n_2 = 5$) has a one-tailed probability under H_0 of $p < 0.004$. Since this p is less than $\alpha = 0.05$, our decision is to reject H_0 in favor of H_1. *There is a tendency for nonnuclear bloc members to communicate with the leader of their bloc rather than with the external nuclear power—the system prior to the spread of nuclear capability is not only bipolar, it is tightly bipolar.*

4.5 *The* Nth-*Country Situation: Conditions and Linkages*

The reader will, we believe, grant, on the evidence contained in the foregoing section, that the "cold war system" as we have defined it, emerged in the binuclear periods of INS-8. In this section we will attempt to assess the effects of the diffusion of nuclear weapons capability on this "cold war system."

4.5.a PERCEPTIONS OF THREAT FROM NATIONS EXTERNAL TO THE BLOC IN THE *n*TH-COUNTRY SITUATION

Figure 2.1 indicates a predicted reduction in the level of perceived threat from the external bloc (i.e., C7) as a result of the spread of nuclear capability.

Null Hypothesis—H_0: there is no difference between the level of perceived threat, from the external bloc, before and after the spread of nuclear capability. H_1: the level of perceived threat will be lower after the spread of nuclear weapons.

Statistical Test—Our measure of threat perception is, as before, Scale #2 on the Systems Questionnaire (Appendix I). The comparison will be made on the 24 inter-bloc ratings before and after spread took place (i.e., Periods 4 and 12, see Figure 3.2, above). The U Test will be used in this comparison.

Significance Level—Let $\alpha = 0.05$. $n_1 = 24 =$ the number of inter-bloc dyads in the pre-spread periods; $n_2 = 24 =$ the number of inter-bloc dyads in the post-spread periods.

Sampling Distribution—Same as 4.4.b, above.

Region of Rejection—Same as 4.4.a, above.

Decision—The level of perceived threat for each of the 48 dyads is shown in Table 4.14, together with the rank of the dyad. For these data, $R_1 = 811.5$ and $R_2 = 364.5$. The value of U is determined by substitution of the observed value into Formula 4.2b:

$$U = 876 - R_1 = 64.5.$$

Using Formula 4.1, we find:

$$z = U - 288/47.94 = 4.66.$$

TABLE 4.14

PERCEPTIONS OF INTER-BLOC THREAT

Pre-spread			Post-spread		
Dyad	Score	Rank	Dyad	Score	Rank
1. AE	206	35	1. AE	161	9
2. AO	243	42	2. AO	148	2
3. AY	197	29.5	3. AY	156	5.5
4. EA	207	36.5	4. EA	187	25
5. EI	211	38	5. EI	176	19
6. EU	257	45	6. EU	164	10
7. EZ	207	36.5	7. EZ	157	7
8. IE	198	31	8. IE	201	33
9. IO	272	46	9. IO	192	28
10. IY	224	40	10. IY	165	11
11. OA	186	24	11. OA	130	1
12. OI	220	39	12. OI	154	4
13. OU	286	48	13. OU	175	18
14. OZ	197	29.5	14. OZ	172	15.5
15. UE	185	23	15. UE	182	22
16. UO	279	47	16. UO	200	32
17. UY	236	41	17. UY	179	21
18. YA	150	3	18. YA	169	13
19. YI	189	26.5	19. YI	169	13
20. YU	246	43	20. YU	172	15.5
21. YZ	169	13	21. YZ	178	20
22. ZE	174	17	22. ZE	159	8
23. ZO	252	44	23. ZO	189	26.5
24. ZY	203	34	24. ZY	156	5.5
		$\Sigma = 811.5 = R_1$			$\Sigma = 364.5 = R_2$

Reference to the table of normal probabilities (Siegel, 1956, p. 247) reveals that $z = 4.66$ has a one-tailed probability under H_0 of $p < 0.00003$. Since this p is less than $\alpha = 0.05$, our decision is to reject H_0 in favor of H_1. *After the spread of nuclear weapons, the perception of inter-bloc threat is markedly reduced.*

4.5.b INTER- VS. INTRA-BLOC THREAT IN THE POST-SPREAD PERIODS

Figure 2.1 does not predict the nature of the inter-bloc, intra-bloc comparison, on threat perception after the spread of nuclear capability, but data on this comparison will be presented to aid in the description of the *n*th-country situation.

The level of perceived threat for each of the post-spread dyads is shown in Table 4.15, together with the rank of the dyad. For these data, $R_1 = 301$ and $R_2 = 602$. The value of U is found by substituting the observed value (R_2) into Formula 4.2a:

$$U = 732 - R_2 = 130.$$

From Formula 4.1, we find:

$$z = U - 216/39.34 = 2.19$$
$$p = 0.0143.$$

After the spread of nuclear capability there is still a significant difference between the levels of inter- and intra-bloc threat. There is more to threat than just "capability."

4.5.c IMAGES OF THE BLOC LEADER AFTER THE SPREAD OF NUCLEAR WEAPONS

The eighth "condition" (C8, Figure 2.1, above) relates to the level of dissatisfaction with the hierarchy after the spread of nu-

TABLE 4.15

PERCEPTIONS OF INTER-BLOC AND INTRA-BLOC THREAT

INTER-BLOC DYADS			INTRA-BLOC DYADS		
Dyad	Score	Rank	Dyad	Score	Rank
1. AE	161	18.5	1. AI	174	30
2. AO	148	7	2. AU	189	37.5
3. AY	156	12.5	3. AZ	208	42
4. EA	187	36	4. EO	142	6
5. EI	176	32	5. EY	140	5
6. EU	164	21	6. IA	169	25
7. EZ	157	14.5	7. IU	151	9
8. IE	201	41	8. IZ	149	8
9. IO	192	39	9. OE	117	1
10. IY	165	23	10. OY	159	16.5
11. OA	130	2	11. UA	157	14.5
12. OI	154	10	12. UI	132	3
13. OU	175	31	13. UZ	164	21
14. OZ	172	28	14. YE	164	21
15. UE	182	35	15. YO	172	28
16. UO	200	40	16. ZA	155	11
17. UY	179	34	17. ZI	137	4
18. YA	169	25	18. ZU	161	18.5
19. YI	169	25			
20. YU	172	28			$\Sigma = 301 = R_1$
21. YZ	178	33			
22. ZE	159	16.5			
23. ZO	189	37.5			
24. ZY	156	12.5			
		$\Sigma = 602 = R_2$			

clear capability. However, no *direct* measure of satisfaction-dissatisfaction was employed in INS-8 (*mea culpa*).

By the use of *indirect* measures, we can say a great deal about the "image" of the bloc leader, held by the former nonnuclear nations after diffusion took place. If this image is positive, we can infer satisfaction; if it is negative, we can infer dissatisfaction. Satisfaction or dissatisfaction with the bloc leader will be taken as an indication of a similar attitude toward the hierarchy.

Four measures were used to investigate the image of the bloc leader: (1) HOS expressed toward the leader; (2) DOM expressed toward the leader; (3) perceptions of the leader's "friendliness" (Scale #1, Systems Questionnaire) and (4) perceptions of the leader's "helpfulness" (Scale #4, Systems Questionnaire). Pre-post comparisons were made on all of these measures.

In all four tests, the same five dyads were used (*viz.*, AU, EO, IU, YO, and ZU). The following table indicates the null and experimental hypotheses, the value of *U*, significance level of the observed *U*, and the decision under H_0. The data upon which Table 4.16 is based are found in Table 4.17.

Table 4.16 indicates no uniform change in the image of the bloc leader, after nuclear diffusion took place. In communicating with the bloc leader, the former nonnuclear nations use fewer dominance themes but express about the same level of hostility. Moreover, the bloc leader is seen as about as friendly as before diffusion but less helpful.

TABLE 4.16

IMAGES OF THE BLOC LEADERS[a]

H_0	H_1	n_1	n_2	U	p^b	Decision under H_0
$HOS_{pre} = HOS_{post}$	$HOS_{pre} < HOS_{post}$	5	5	7	ns	accept
$DOM_{pre} = DOM_{post}$	$DOM_{pre} < DOM_{post}$	5	5	4	0.028	reject-wrong direction
$Fr._{pre} = Fr._{post}$	$Fr._{pre} > Fr._{post}$	5	5	13	ns	accept
$He._{pre} = He._{post}$	$He._{pre} > He._{post}$	5	5	3	0.028	reject-right direction

[a] DOM = desire to dominate
HOS = expressed hostility
Fr. = perceived as friendly
He. = perceived as helpful

[b] p based on Siegel's "Table J" (1956, p. 271).

This situation must have been frustrating for the decision-makers in Algo, Erga, Ingo, Yora, and Zena. They communicated more submissiveness (i.e., less dominance) to Omne and Utro but felt less rewarded for it (i.e., Omne and Utro were seen as less helpful to their bloc allies). This ambivalence reflects the manner in which INS-8 was altered by the induced spread of nuclear weapons. Only the nuclear power differential was manipulated; the economic differentials were not.[4] Even after the spread of nuclear weapons the former nonnuclear nations had economic needs which they could not satisfy unilaterally—in other words, while increased nuclear capability changed their perception of threat from the external bloc, it did not reduce the economic dependence felt by the former nonnuclear nations.

If economic dependency continued into the post-spread situation and the leaders of their alliance were judged less helpful than before, we would expect a turning to the opposing bloc leader for aid. If we find this to be the case (see 4.5.j, below), it may be legitimate to argue that reduced perceived helpfulness (the other findings notwithstanding) is a sign of dissatisfaction.

4.5.d THE CONDITION OF THREAT WITHIN THE BLOC

Figure 2.1 indicates a hypothesized increase in intra-bloc "tension" (now, "threat;" i.e., C9) after the *n*th-country situation emerges. As fellow bloc members gain in military capability, they should appear relatively more threatening to each other.

Null Hypothesis—H_0: there is no change in the level of perceived intra-bloc threat after the spread of nuclear weapons. H_1: there will be an increase in perceived intra-bloc threat after the diffusion of nuclear capability.

Statistical Test—Our measure of threat perception is Scale #2 on the Systems Questionnaire (Appendix I). The comparison will be made between the ratings of the 18 intra-bloc dyads before the spread took place (Period 4) and after experience with the *n*-nuclear world (Period 12; Figure 2.2, above). The *U* Test will be used to test this hypothesis.

Significance Level—Let $\alpha = 0.05$. $n_1 = 18$ = the number of intra-bloc dyads prior to spread; $n_2 = 18$ = the number of intra-bloc dyads after spread.

Sampling Distribution—The probabilities associated with the occurrence under H_0

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[4] This is highly unrealistic if one thinks of the economic development which must precede independent nuclear development in the real world—it is, however, highly defensible in terms of experimental controls.

TABLE 4.17

IMAGES OF THE BLOC LEADERS: DATA ON HOSTILITY, DOMINANCE, FRIENDLINESS, AND HELPFULNESS

A. HOS Themes Expressed to Bloc Leader Pre and Post ($R_2 = 33$)

Dyad	Pre HOS Score	Rank	Post HOS Score	Rank
1. AU	– 38.0	9	– 48.9	8
2. EO	–106.8	2	–107.7	1
3. IU	– 54.8	7	– 63.8	4
4. YO	– 21.2	10	– 67.5	3
5. ZU	– 62.8	5	– 62.7	6

B. DOM Themes Expressed to Bloc Leader Pre and Post ($R_2 = 36$)

Dyad	Pre DOM Score	Rank	Post DOM Score	Rank
1. AU	18.7	6	– 1.7	3
2. EO	0.4	4	17.1	5
3. IU	31.7	8	25.0	7
4. YO	55.9	10	– 3.3	2
5. ZU	32.3	9	– 32.7	1

C. Perceived Friendliness of Bloc Leader Pre and Post ($R_2 = 27$)

Dyad	Pre Fr. Score	Rank	Post Fr. Score	Rank
1. AU	162	8	175	10
2. EO	134	3	128	2
3. IU	171	9	142	4
4. YO	124	1	143	5
5. ZU	152	6	161	7

D. Perceived Helpfulness of Bloc Leader Pre and Post ($R_2 = 37$)

Dyad	Pre He. Score	Rank	Post He. Score	Rank
1. AU	183	10	169	8
2. EO	152	7	118	1
3. IU	177	9	138	3
4. YO	143	5	122	2
5. ZU	146	6	139	4

of values as small as an observed U for $9 < n_2 < 20$ are determined by using Siegel's "Table K" (1956, pp. 274–7).

Rejection Region—Same as 4.4.f, above.

Decision—The level of perceived threat for each dyad is shown in Table 4.18.

For these data, $R_1 = 386.5$ and $R_2 = 279.5$. The value of U is determined by substitution of the observed value (R_1) into Formula 4.2b:

$$U = 495 - R_1 = 108.5.$$

Reference to Siegel's "Table K" (1956, p. 277) reveals that $U = 108.5$ ($n_1 = 18$; $n_2 = 18$) has a one-tailed probability under H_0 of $p < 0.05$. Since this p is less than $\alpha = 0.05$, our decision is to reject H_0 in favor of H_1. *After the spread of nuclear weapons, there is an increase in the perception of threat from members of the internal bloc.* This change appears to stem directly from the spread of nuclear weapons capability—it does not, contrary to Figure 2.1, appear to be mediated by the level of dissatisfaction with the bloc.

4.5.e COHESION AFTER THE SPREAD OF NUCLEAR WEAPONS

The tenth "condition" (C10, Figure 2.1, above) is a predicted decrease in the cohesiveness of the blocs. In the pre-spread system, it was found that there was a marked tendency for nations to interact within the bloc rather than between the blocs. The prediction is that this tendency will not persist after the diffusion of nuclear capability.

Null Hypothesis—H_0: there is no difference between the level of interaction within

TABLE 4.18

INTRA-BLOC THREAT PERCEPTION

Dyad	Pre-score	Rank	Post-score	Rank
1. AI	173	31	174	32.5
2. AU	182	34	189	35
3. AZ	156	22	208	36
4. EO	149	17.5	142	13
5. EY	144	14	140	11
6. IA	146	15	169	28
7. IU	172	29.5	151	19
8. IZ	152	20	149	17.5
9. OE	136	8	117	3
10. OY	141	12	159	24
11. UA	174	32.5	157	23
12. UI	148	16	132	6
13. UZ	130	4.5	164	26.5
14. YE	116	2	164	26.5
15. YO	136	8	172	29.5
16. ZA	136	8	155	21
17. ZI	114	1	137	10
18. ZU	130	4.5	161	25
		$\Sigma = 279.5 = R_2$		$\Sigma = 386.5 = R_1$

and between the blocs. H_1: the tendency to interact along bloc lines (found in the pre-spread system) persists after the spread of nuclear capability.

Statistical Test—Message frequency in each of the 42 dyads is the measure of interaction. The comparison will be made between inter-bloc and intra-bloc dyads. This is essentially the same test that was used to investigate cohesion in the pre-spread periods. The hypothesis will be tested in the data from Periods 7 through 12. The over-all increase in communication rate (4.5.f, below) in the post-spread periods precludes meaningful, direct, pre-post comparison. The *U* Test will be used in the examination of this hypothesis.

Significance Level—Let $\alpha = 0.05$. $n_1 = 18$ = the number of intra-bloc dyads; $n_2 = 24$ = the number of inter-bloc dyads. (The terms of reference "inter-bloc" and "intra-bloc" refer to the dyads in their initial bloc configuration; i.e., at time "t_0," they are used to make comparison with the pre-spread system possible and not to indicate that the bloc persisted unchanged into the *n*-nuclear world.)

Sampling Distribution—Same as 4.4.b, above.

Rejection Region—Same as 4.4.a, above.

Decision—The dyadic communication frequencies are shown in Table 4.19, together with the ranks of the dyads. For these data, $R_1 = 418$ and $R_2 = 485$. The value of *U* is determined by substitution of the observed value (R_2) into Formula 4.2a:

$$U - 732 - R_2 = 247.$$

From Formula 4.1, we find:

$$z = U - 216/39.34 = 0.79.$$

Reference to the table of normal probabilities (Siegel, 1956, p. 247) reveals that $z = 0.79$ has a one-tailed probability under H_0 of $p = 0.2148$. Since this p is greater than $\alpha = 0.05$, our decision is to not reject H_0. *There may be as much interaction (cohesion) between the blocs as within the blocs—the marked preference for communicating within the bloc, which existed prior to nuclear diffusion, is no longer evident.*

TABLE 4.19

MESSAGE FREQUENCY IN INTER- AND INTRA-BLOC DYADS

Inter-bloc Dyads			Intra-bloc Dyads		
Dyad	f	Rank	Dyad	f	Rank
1. AE	64	3	1. AI	68	5
2. AO	168	38	2. AU	127	27
3. AY	60	1	3. AZ	72	6.5
4. EA	79	11.5	4. EO	254	42
5. EI	75	9.5	5. EY	111	21
6. EU	148	33	6. IA	67	4
7. EZ	80	13	7. IU	160	36
8. IE	74	8	8. IZ	89	15
9. IO	157	34.5	9. OE	211	41
10. IY	91	16	10. OY	157	34.5
11. OA	128	28	11. UA	118	24
12. OI	139	31	12. UI	137	30
13. OU	185	40	13. UZ	120	25
14. OZ	116	22	14. YE	106	20
15. UE	121	26	15. YO	163	37
16. UO	181	39	16. ZA	72	6.5
17. UY	93	17	17. ZI	79	11.5
18. YA	63	2	18. ZU	143	32
19. YI	96	19			
20. YU	117	23			$\Sigma = 418 = R_1$
21. YZ	95	18			
22. ZE	75	9.5			
23. ZO	136	29			
24. ZY	86	14			
		$\Sigma = 485 = R_2$			

TABLE 4.20

MESSAGE FREQUENCY IN SYSTEM-RUNS

Run	Pre f	Rank	Run	Post f	Rank
1.	305	26	1.	472	33
2.	212	11	2.	237	14
3.	180	8	3.	212	11
4.	303	25	4.	321	27
5.	262	18	5.	292	22.5
6.	238	15	6.	459	31
7.	176	7	7.	276	20
8.	166	5	8.	226	13
9.	157	4	9.	422	30
10.	297	24	10.	620	34
11.	212	11	11.	469	32
12.	184	9	12.	325	28
13.	174	6	13.	246	16
14.	254	17	14.	330	29
15.	263	19	15.	292	22.5
16.	133	2	16.	154	3
17.	98	1	17.	286	21
		$\Sigma = 208 = R_1$			$\Sigma = 387 = R_2$

TABLE 4.21

CORRELATION OF MESSAGE FREQUENCY PRE AND POST BY RUN

System-run	Rank Pre	Rank Post	d	d^2
1.	17	16	− 1	1.0
2.	9.5	4	− 5.5	30.25
3.	7	2	− 5	25.0
4.	16	10	− 6	36.0
5.	13	8.5	− 4.5	20.25
6.	11	14	3	9.0
7.	6	6	0	0.0
8.	4	3	− 1	1.0
9.	3	13	10	100.0
10.	15	17	2	4.0
11.	9.5	15	5.5	30.25
12.	8	11	3	9.0
13.	5	5	0	0.0
14.	12	12	0	0.0
15.	14	8.5	− 5.5	30.25
16.	2	1	− 1.0	1.0
17.	1	7	6	36.0
				$\Sigma d^2 = 333.00$

4.5.f RELIABILITY OF COMMUNICATION FREQUENCY

A rough estimate of the stability of communication frequencies (a ubiquitous measure in this study) can be gained by an examination of message frequencies in the seventeen system-runs before and after the experimental intervention. There is a significant increase in total communication after the spread of nuclear weapons (though not necessarily because of it). Table 4.20 contains the pre-post totals for each system-run.

For these data, $U = 55$ ($n_1 = 17$; $n_2 = 17$); from Siegel's "Table K" (1956, p. 274) we find that $p < 0.001$. There is a significant increase in the level of interaction in Periods 7 through 12.

This increase notwithstanding, the relative position of the system-runs is fairly constant. Table 4.21 indicates the rankings of the seventeen "worlds" pre and post.

For these data, $r_s = 0.59$; $t = 2.85$; $p < 0.01$.

The message-frequency data are also poolable. A Friedman Two-Way Analysis of Variance reveals that:

$N = 7$ = number of nations
$K = 17$ = number of replications
$df = 16$
$\chi_r^2 = (0.005)\ (80{,}262.5) - 378 = 23.3$
$p > 0.10$.

If we take into account within-world variability, the relationship of pre-post communication frequency is higher than if we aggregate within worlds. Table 4.22 shows the rankings of the 42 dyads pre and post. For these data, $r_s = 0.71$; $t = 6.43$; $p < 0.0005$. Communication frequency is a relatively stable measure.

4.5.g THREAT AND COHESION AFTER THE SPREAD OF NUCLEAR CAPABILITY

Figure 2.1 indicates a linkage between threat perception and cohesion (C7 → C10); this linkage was found in the prespread system (Section 4.4.j, above) but it *does not* hold up after the shift in level of perceived threat.

Null Hypothesis—H_0: there is no rela-

TABLE 4.22

CORRELATION OF MESSAGE FREQUENCY PRE AND POST BY DYAD

Dyad	Rank Pre	Rank Post	d	d^2
1. AE	3	3	0	0.0
2. AO	30	38	8	64.0
3. AY	4	1	– 3	9.0
4. EA	8.5	11.5	3	9.0
5. EI	14.5	9.5	– 5	25.0
6. EU	23	33	10	100.0
7. EZ	7	13	6	36.0
8. IE	12	8	– 4	16.0
9. IO	21	34.5	13.5	182.25
10. IY	16	16	0	0.0
11. OA	27	28	1	1.0
12. OI	14.5	31	16.5	272.25
13. OU	35	40	5	25.0
14. OZ	5	22	17	289.0
15. UE	10.5	26	15.5	240.25
16. UO	34	39	5	25.0
17. UY	13	17	4	16.0
18. YA	8.5	2	– 6.5	42.25
19. YI	25	19	– 6	36.0
20. YU	21	23	2	4.0
21. YZ	2	18	16	256.0
22. ZE	6	9.5	3.5	12.25
23. ZO	10.5	29	18.5	342.25
24. ZY	1	14	13	169.0
25. AI	17.5	5	–12.5	156.25
26. AU	37	27	–10	100.0
27. AZ	19	6.5	–12.5	156.25
28. EO	41	42	1	1.0
29. EY	29	21	– 8	64.0
30. IA	26	4	–22	448.0
31. IU	36	36	0	0.0
32. IZ	24	15	– 9	81.0
33. OE	38.5	41	2.5	6.25
34. OY	38.5	34.5	– 4	16.0
35. UA	32	24	– 8	64.0
36. UI	31	30	– 1	1.0
37. UZ	33	25	– 8	64.0
38. YE	28	20	– 8	64.0
39. YO	42	37	– 5	25.0
40. ZA	17.5	6.5	–11	121.0
41. ZI	21	11.5	– 9.5	90.25
42. ZU	40	32	– 8	64.0
				$\Sigma d^2 = 3{,}530.5$

tionship between perceptions of threat and level of interaction (our measure of cohesion). H_1: the higher the perceived threat, the lower the interaction.

Statistical Test—Tables 4.15 and 4.19 provide ranked measures of perceived threat and interaction. The Spearman r_s will be used to test this hypothesis.

Significance Level—Same as 4.4.d, above.

Sampling Distribution—Same as 4.4.d, above.

Rejection Region—Same as 4.4.d, above.

Decision—The rankings of each dyad, on the two variables, are shown in Table 4.23.

TABLE 4.23

CORRELATION OF THREAT AND COHESION

Dyad	Threat Rank	Cohesion Rank	d	d^2
1. AE	18.5	3	-15.5	240.25
2. AO	7	38	31	961.0
3. AY	12.5	1	-11.5	132.25
4. EA	36	11.5	-34.5	1,190.25
5. EI	32	9.5	-22.5	506.25
6. EU	21	33	12	144.0
7. EZ	14.5	13	- 1.5	2.25
8. IE	41	8	-33	1,089.0
9. IO	39	34.5	- 4.5	20.25
10. IY	23	16	- 7	49.0
11. OA	2	28	26	676.0
12. OI	10	31	21	441.0
13. OU	31	40	9	81.0
14. OZ	28	22	- 6	36.0
15. UE	35	26	- 9	81.0
16. UO	40	39	- 1	1.0
17. UY	34	17	-17	289.0
18. YA	25	2	-23	529.0
19. YI	25	19	- 6	36.0
20. YU	28	23	- 5	25.0
21. YZ	33	18	-15	225.0
22. ZE	16.5	9.5	- 7	49.0
23. ZO	37.5	29	- 8.5	72.25
24. ZY	12.5	14	1.5	2.25
25. AI	30	5	-25	625.0
26. AU	37.5	27	-10.5	110.25
27. AZ	42	6.5	-35.5	1,260.25
28. EO	6	42	36	1,296.0
29. EY	5	21	16	256.0
30. IA	25	4	-21	441.0
31. IU	9	36	27	729.0
32. IZ	8	15	7	49.0
33. OE	1	41	40	1,600.0
34. OY	16.5	34.5	18	324.0
35. UA	14.5	24	9.5	90.25
36. UI	3	30	27	729.0
37. UZ	21	25	4	16.0
38. YE	21	20	- 1	1.0
39. YO	28	37	9	81.0
40. ZA	11	6.5	- 4.5	20.25
41. ZI	4	11.5	7.5	56.25
42. ZU	18.5	32	13.5	182.25
				$\Sigma d^2 = 14{,}744.5$

For these data, $\Sigma d^2 = 13{,}689.5$. The value of r_s is determined by substitution of the observed value into Formula 4.4:

$$r_s = 1 - \frac{(6)\ (14{,}744.5)}{74{,}046} = -0.195.$$

Using Formula 4.3, we find:

$$t = -0.195\ (6.45) = -1.26.$$

Reference to the "Table of Critical Values of t" (Siegel, 1956, p. 248) reveals that $t = -1.26$ ($df = 40$) has a one-tailed probability under H_0 of $p > 0.05$. Since this p is greater than $\alpha = 0.05$, our decision is to not reject H_0. *The predicted link between*

TABLE 4.24

CORRELATION OF THREAT AND COHESION: INTRA-BLOC

Dyad	Threat Rank	Cohesion Rank	d	d^2
1. AI	16	2	–14	196
2. AU	17	11	– 6	36
3. AZ	18	3.5	–14.5	210.25
4. EO	5	18	13	169
5. EY	4	8	4	16
6. IA	14	1	–13	169
7. IU	7	15	8	64
8. IZ	6	6	0	0
9. OE	1	17	16	256
10. OY	10	14	4	16
11. UA	9	9	0	0
12. UI	2	12	10	100
13. UZ	12.5	10	– 2.5	6.25
14. YE	12.5	7	– 5.5	30.25
15. YO	15	16	1	1
16. ZA	8	3.5	– 4.5	20.25
17. ZI	3	5	2	4
18. ZU	11	13	2	4
				$\Sigma d^2 = 1{,}298.00$

threat and cohesion does not emerge. This negative finding seems to arise from the variability of threat perception in the external bloc—this judgment is based on the finding in the next section.

4.5.h INTRA-BLOC THREAT AND COHESION

Figure 2.1 predicts a negative relationship between perceived intra-bloc threat and level of interaction ($C9 \rightarrow C10$).

Null Hypothesis—H_0: there is no relationship between perception of threat within the bloc and interaction within the bloc. H_1: the greater the perception of threat, the lower the level of interaction (cohesion).

Statistical Test—Tables 4.15 and 4.19 contain data on the levels of threat perception and interaction in the intra-bloc dyads. The Spearman r_s will be used to test this hypothesis.

Significance Level—Let $\alpha = 0.05$. $N = 18$ = the number of intra-bloc dyads ranked on these variables.

Sampling Distribution—Same as 4.4.d, above.

Rejection Region—Same as 4.4.d, above.

Decision—The rankings of each dyad on the two variables are shown in Table 4.24. For these data, $\Sigma d^2 = 1{,}298$. The value of r_s is determined by substitution of the observed value into Formula 4.4:

$$r_s = 1 - \frac{6(1{,}298)}{5{,}814} = -0.34.$$

Using Formula 4.3, we find:

$$t = -0.34\ (4.25) = -1.445.$$

Reference to the "Table of Critical Values of t" (*ibid.*) reveals that $t = 1.445$ ($df = 16$) has a one-tailed probability under H_0 of $0.05 < p < 0.10$. Since this p is greater than $\alpha = 0.05$, but lies in the "region of doubt" in the predicted direction, we do not reject H_0 but consider the finding worth investigating in the *real* world. *Threat perception and level of interaction (in intra-bloc dyads) appear to be negatively related but the relationship may be random.*

TABLE 4.25

COMMUNICATION FREQUENCY IN INTRA-BLOC DYADS

Dyads which Involve Nuclear Nation[a]	f	Rank	Dyads which Do not Involve Nuclear Nation[a]	f	Rank
1. AU	127	11	1. AI	68	2
2. UA	118	9	2. AZ	72	3.5
3. EO	254	18	3. EY	111	8
4. OE	211	17	4. IA	67	1
5. IU	160	15	5. IZ	89	6
6. UI	137	12	6. YE	106	7
7. YO	163	16	7. ZA	72	3.5
8. OY	157	14	8. ZI	79	5
9. ZU	143	13			
10. UZ	120	10			$\Sigma = 36 = R_1$
		$\Sigma = 135 = R_2$			

[a] The label "Nuclear" refers to the nation prior to the experimental intervention.

4.5.i HIERARCHY AFTER THE SPREAD OF NUCLEAR WEAPONS

The eleventh "condition" (C11, Figure 2.1, above) is described as a dissolution of the hierarchical structure of the blocs. In this section, we will examine the communication of the blocs to determine whether the two "wheel" structures found above (Section 4.4.1) continue after the experimental intervention.

Null Hypothesis—H_0: there is no difference between the frequency of intra-bloc communication directed toward and initiated by Omne and Utro and that directed toward and initiated by the former nonnuclear nations. H_1: Omne and Utro will continue to receive and send more communication than the former nonnuclear nations within the blocs.

Statistical Test—Communication frequency in the intra-bloc dyads (Table 4.19) will provide the data base. The comparison will be made between intra-bloc dyads in which Omne and Utro are parties to the interaction and dyads in which they are not. The *U* Test will be used in this analysis.

Significance Level—Same as 4.4.1, above.

Sampling Distribution—Same as 4.4.f, above.

Rejection Region—Same as 4.4.f, above.

Decision—The frequency of communication for each dyad is shown in Table 4.25, together with the rank of the dyad.

For these data, $R_1 = 36$ and $R_2 = 135$. The value of U is found by substitution of the observed value into Formula 4.2a:

$$U = 135 - R_2 = 0.$$

Reference to Siegel's "Table K" (*ibid.*, p. 274) reveals that $U = 0$ ($n_1 = 8$; $n_2 = 10$) has a one-tailed probability under H_0 of $p < 0.001$. Since this p is less than $\alpha = 0.05$, our decision is to reject H_0 in favor of H_1. *The hierarchical structure of the bloc does not break down under the impact of the spread of nuclear weapons.* This is a clearly negative finding! Perhaps the analysis in the section to follow will shed some light on potential reasons for the continuance of the hierarchy?

4.5.j THE TIGHTNESS OF THE BIPOLARITY AFTER THE SPREAD OF NUCLEAR CAPABILITY

The hierarchies have persisted in the *n*th-country system but the perception of external bloc threat was significantly reduced. If the hierarchies are based solely on military necessity, these are inconsistent

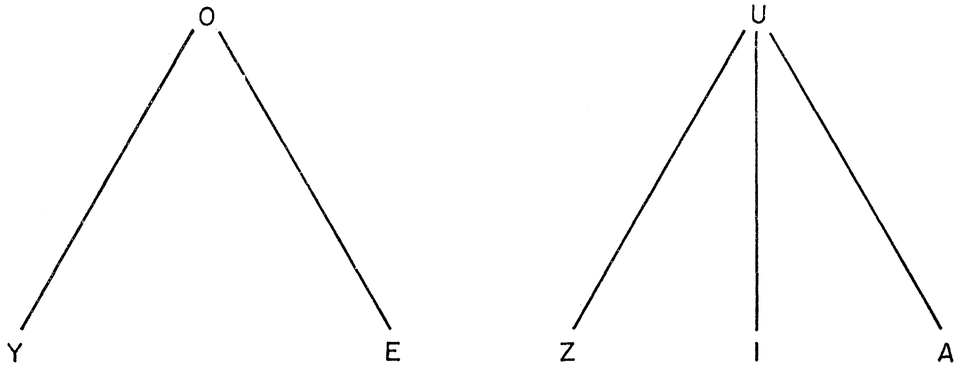

FIG. 4.3. Pre-spread international communication.

findings. However, the findings can be considered consistent if some other motivation for submission to the hierarchical structure can be found.

Clues to this motivation are present in the "images of the bloc leader" held by the former nonnuclear nations (Section 4.5.c, above). The leaders were seen as being less "helpful" and just as "friendly" after spread took place. If threat is reduced, the locus of this decreased helpfulness might reasonably be expected to be in the military realm. Unfortunately, the participants were not asked to differentiate between kinds of helpfulness.

It was argued above (Section 4.4.m) that if a clear preference for interaction with the leader of a nation's own bloc emerged, the hierarchy must have some basis beyond the economic differentials. By the same reasoning, if no clear preferences are exhibited, the hierarchy might be considered to reflect the economic differentials which were part of the starting situation and persisted throughout INS-8.[5]

We found in the pre-spread system a clear preference for interaction with the leader of a nation's own bloc. The world communication system looked like the idealized model in Figure 4.3; in this model the letters are nations and the lines represent the modal communication links.

This communication system was labeled a "tight (i.e., hierarchical) bipolarity." It remains to be determined whether this communication system persists along with the persistence of the hierarchies.

Null Hypothesis—H_0: the former nonnuclear nations have no clear preference for the bloc leader with whom they communicate. H_1: the former nonnuclear nations will continue to exhibit a tendency to communicate primarily with the leader of their own bloc.

Statistical Test—Communication frequency (Table 4.19), of former nonnuclear nations directed toward Omne and Utro, is the needed measure. Comparison will be made between frequency within the bloc and frequency across bloc lines. The *U* Test will be used.

Significance Level—Same as 4.4.m, above.

Sampling Distribution—Same as 4.4.m, above.

Rejection Region—Same as 4.4.m, above.

Decision—The communication frequency

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[5] Stillman and Pfaff (1960) argue that the cohesion of the *real* world bloc-alliances has already decreased under the impact of increased economic capability and that along with this decreased cohesion has gone a dissolution of the post-WWII hierarchical decision structures (p. 147 ff.).

TABLE 4.26

COMMUNICATION FREQUENCY OF NONNUCLEAR NATIONS WITH NUCLEAR NATIONS[a]

Inter-bloc Dyads	f	Rank	Intra-bloc Dyads	f	Rank
1. AO	168	8	1. AU	127	1
2. EU	148	4	2. EO	254	10
3. IO	157	5	3. IU	160	6
4. YU	185	9	4. YO	163	7
5. ZO	136	2	5. ZU	143	3
		$\Sigma = 28 = R_2$			$\Sigma = 27 = R_1$

[a] The labels "Nuclear" and "Nonnuclear" refer to the nations prior to the experimental intervention.

of each dyad is shown in Table 4.26, together with the rank of each dyad.

For these data, $R_1 = 27$ and $R_2 = 28$. The value of U is given by Formula 4.2a:

$$U = 40 - R_2 = 12.$$

Reference to Siegel's "Table J" (*ibid.*, p. 271) reveals that $U = 12$ ($n_1 = 5$; $n_2 = 5$) has a one-tailed probability under H_0 of $p = 0.50$. Since this p is greater than $\alpha = 0.05$, our decision is to not reject H_0 and reject H_1. *After the spread of nuclear weapons, the former nonnuclear nations may be as likely to communicate with the external bloc leader as with their own bloc leader. The bipolarity appears to fragment; the hierarchies appear to be based on the economic differentials.*

The world communication system is no longer described by the model in Figure 4.3; a new system has emerged. This idealized model appears as Figure 4.4.

4.6 Summary: The Status of the Model

We are now in possession of sufficient data to permit an answer to the "macro-question" posed above: "Is the international system different before and after the spread of nuclear weapons?" The answer is an unqualified "Yes."

In the binuclear system, all of the predicted "conditions" were established, but two of the predicted linkages (C3 → C4 and C4 → C5) were not.

The system was comprised of two hierarchical, cohesive bloc-alliances. The nations of the external bloc were perceived as

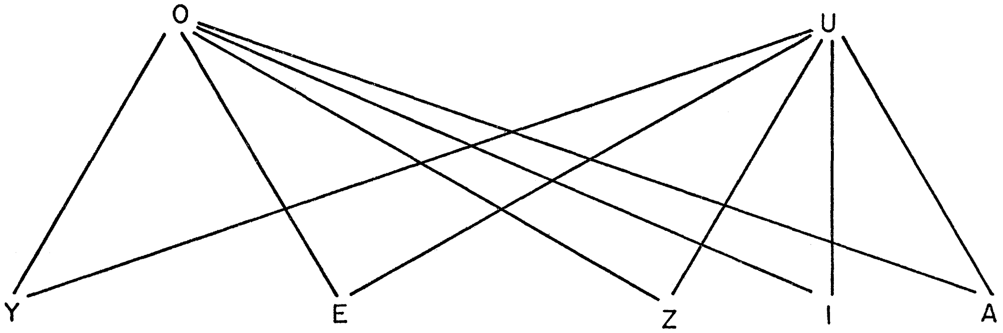

FIG. 4.4. Post-spread international communication.

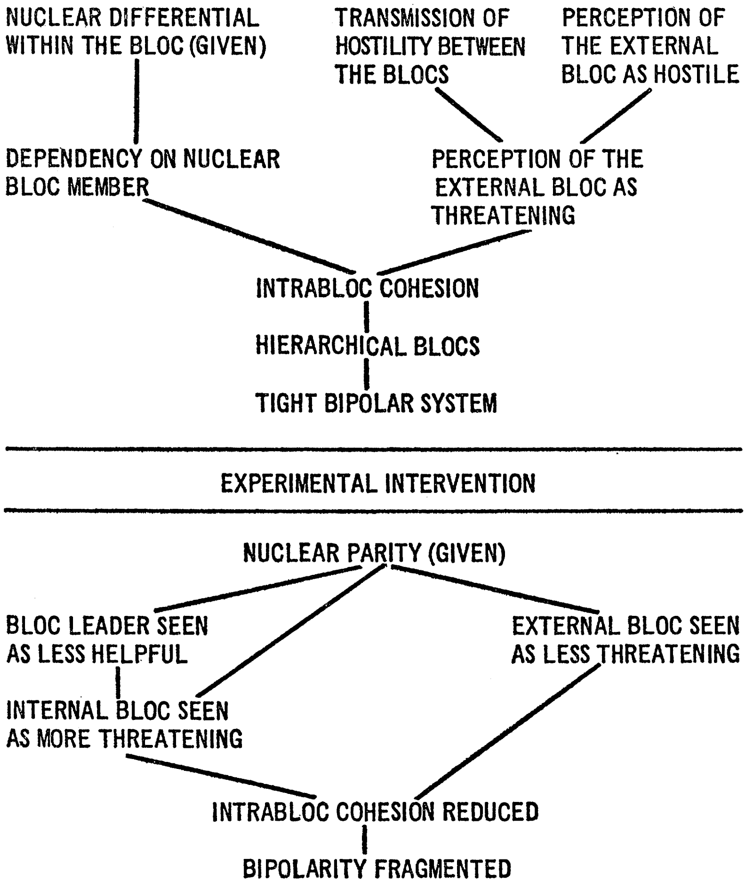
NUCLEAR DIFFERENTIAL WITHIN THE BLOC (GIVEN)
TRANSMISSION OF HOSTILITY BETWEEN THE BLOCS
PERCEPTION OF THE EXTERNAL BLOC AS HOSTILE
DEPENDENCY ON NUCLEAR BLOC MEMBER
PERCEPTION OF THE EXTERNAL BLOC AS THREATENING
INTRABLOC COHESION
HIERARCHICAL BLOCS
TIGHT BIPOLAR SYSTEM
EXPERIMENTAL INTERVENTION
NUCLEAR PARITY (GIVEN)
BLOC LEADER SEEN AS LESS HELPFUL
EXTERNAL BLOC SEEN AS LESS THREATENING
INTERNAL BLOC SEEN AS MORE THREATENING
INTRABLOC COHESION REDUCED
BIPOLARITY FRAGMENTED

FIG. 4.5. A model of empirical findings INS-8.

more hostile and threatening than the nations of the internal bloc. The communication between the blocs was characterized by a greater level of expressed hostility than the communication within the blocs. The nonnuclear nations expressed dependency upon the nuclear bloc leader—a dependency which appears to be related to outgroup hostility and threat. (However, neither correlation coefficient was high enough to rule out random occurrence.) The dependency on the bloc leader and the hierarchical ordering of the blocs stem from both military and economic insufficiencies—the economic insufficiency continued into the post-spread situation. In sum, the binuclear system is tightly bipolar.

Four key elements of the pre-spread system are different after the spread of nuclear capability: (1) threat external to the bloc is reduced; (2) threat internal to the bloc is increased; (3) the cohesiveness of the blocs is reduced; and (4) the bipolarity is fragmented. All of these add up to a step-level change in the "cold war system."

Figure 4.5 is a reformulation of Figure 2.1, in light of the fidings in INS-8. (To aid comparison with Figure 4.5, Figure 2.1 has been repeated.)

(N.B.: C*i* indicates the *i*th condition in a chain of conditions which is hypothesized as being relevant in the transformation of a steady state A into another steady state B.)

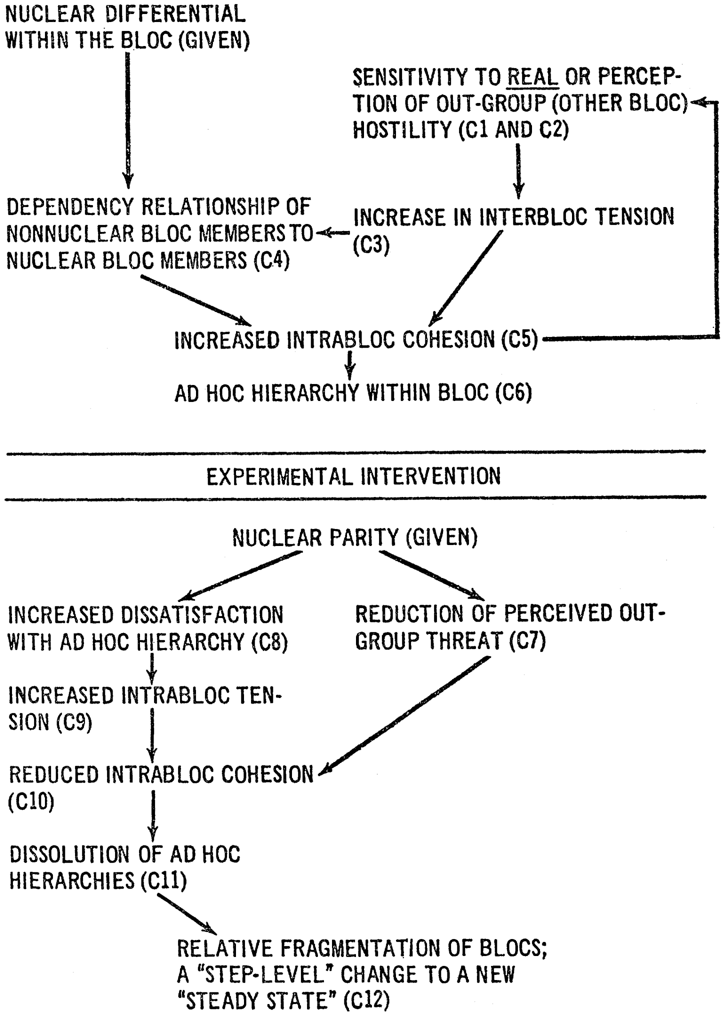
NUCLEAR DIFFERENTIAL WITHIN THE BLOC (GIVEN)
SENSITIVITY TO REAL OR PERCEPTION OF OUT-GROUP (OTHER BLOC) HOSTILITY (C1 AND C2)
DEPENDENCY RELATIONSHIP OF NONNUCLEAR BLOC MEMBERS TO NUCLEAR BLOC MEMBERS (C4)
INCREASE IN INTERBLOC TENSION (C3)
INCREASED INTRABLOC COHESION (C5)
AD HOC HIERARCHY WITHIN BLOC (C6)
EXPERIMENTAL INTERVENTION
NUCLEAR PARITY (GIVEN)
INCREASED DISSATISFACTION WITH AD HOC HIERARCHY (C8)
REDUCTION OF PERCEIVED OUT-GROUP THREAT (C7)
INCREASED INTRABLOC TENSION (C9)
REDUCED INTRABLOC COHESION (C10)
DISSOLUTION OF AD HOC HIERARCHIES (C11)
RELATIVE FRAGMENTATION OF BLOCS; A "STEP-LEVEL" CHANGE TO A NEW "STEADY STATE" (C12)

FIG. 2.1. Hypotheses linkings for INS-8.

CHAPTER V

Questions of generalizing: from ins-8 to the real world

INS-8 registered successes. A high level of prediction was accomplished; that is to say, changes in the simulated international system, after the spread of nuclear capability, conformed in most respects to the theoretical model posited in advance of the experiments. The pre-spread system was a plausible model of reality, i.e., the pattern of interaction, which developed prior to diffusion of nuclear capability, resembled real world patterns which have developed since the end of World War II.

This "pattern matching" is highly desirable. With respect to the validity of experimental findings, Zelditch and Evans caution, "before experimenting on a simulate the investigator ought to run a sufficiently long series of uniformity trials to show that, left to itself, the simulate behaves like the process simulated at least in those ways necessary to investigation" (1962, p. 60). The real world pattern matching in the pre-spread periods of INS-8 would seem to meet this requirement.

Of less direct theoretical import but nonetheless significant was the development of sensitive measuring instruments—particularly the technique of content analysis. The instruments will permit the study of cold war phenomena outside of the laboratory. Further, purely methodological investigations of the interrelations among measuring instruments will have to be performed before we will feel entirely confident that content analysis is measuring the same qualities as the standard measuring instrument, e.g., semantic-differential. These studies are planned.

But these "successes" by no means eliminate all problems and reservations concerning the meaning of the findings. To question the "meaning" of the findings is to make public the author's concern about the generality of knowledge derived from the laboratory. What is the relationship of knowledge about the behavior of the simulate to knowledge about the real system? Or, more directly, what is the relationship of the simulate to the real international system?

We do not argue that the inter-nation simulation is a complete representation (i.e., is totally isomorphic) of all aspects of the international system. However, we do not accept the argument that we have merely gained knowledge about the behavior of high school students in a defined laboratory situation. But where between these extremes, on this continuum of generalizability, do the findings from INS-8 fall?

Any answer to this question must derive initially from the assumptions of the simulation designers about the correspondence of "concrete" and "analytic" structures (Levy, 1958) in the simulation to the same structures in the real international system, and ultimately must derive from the pragmatic test—prediction of real world behavior.

Among the "concrete" structures (i.e., observable entities or types of behavior) represented in the simulation are "nation," "decision-maker," "alliance," "trade," "war," "message," and "international organization." Some of the "analytic" structures (i.e., non-observable relations and processes) represented in the INS are "public opinion," "communication," "communication net," "validation of decisions," and "cohesion of alliances."

From these two lists, it can be seen that the "concrete" structures appear most different after the transposition from the natural setting to the laboratory. The "analytic" structures are linguistic conventions used to describe actions found in both research settings and are, by definition, isomorphic in both loci.

In the context of these concepts the problem of generalizing from the artificial setting to the political world is the problem of determining whether the change in "concrete" structure also alters the nature of the performance of the unit in its relationships with other units. For example, the *process* by which a decision is reached in the simulate is more apt to be the same after transposition to the laboratory than is the content of decisions under the same transformation. This belief informed the decision to concentrate on interaction process in this study.

Snyder contends that, "the primary aim of laboratory representations is to set key variables and their interrelationships *in motion* and to create, explicitly, imitations of and substitutes for the hidden explanatory or conditioning factors assumed to operate in life. Moreover, the experimental situation is usually designed to achieve *not actual effects* observed outside of the laboratory but *equivalent kinds of effects* using the most economical representations of causal variables" (1962, p. 109).

The ability to set key variables and their interrelations in motion and to achieve equivalent kinds of effects or to achieve a degree of correspondence between laboratory and real world structures is a function of the adequacy of the theory which informs the construction of the operating model. Theory indicates which variables and interrelations are central to the reality being modeled; the correspondence of the model to reality after operation (i.e., its predictiveness) is a test of the salience of the variables chosen for inclusion in the simulate, and of the fidelity of the reproduction of the interrelations among these variables.

Failure to predict is a signal that adjustments in the theory need to be made—new variables need to be included and/or old interrelations need to be reset. This is the essence of the theory-building aspect of laboratory experimentation: a cycle of THEORY-BUILDING, EXPERIMENTATION, PREDICTION, OBSERVATION, THEORY-BUILDING . . . until the model is fine-tuned.

INS-8 is the culmination of three phases of this cycle: theory-building and model construction in INS's 1 through 7; experimentation and prediction in INS-8. Observation of the predicted phenomena, in the real world, must await the arrival of the *n*th-country situation.

APPENDIX I

Policy Planning Aid #3

This document is designed to aid you in your planning of future international decisions. The questions are a simplified form of the kinds of questions foreign policy decision-makers ask of the world situation. The fact that your answers may differ from time to time reflects the changeable nature of the world situation.

In addition to helping you clarify your thinking about the other nations in the world, this document will serve as a permanent record of your views of the world situation and, thereby, help us to understand your picture of the world for experimental purposes.

In the questions below you will be asked to rate the other nations on various qualities; two or more nations may be rated as equal but a rating must be given to each of the six nations.

Example: Indicate the *courteousness to your nation* of the other six nations.

1		2.3			4
extremely courteous	very	quite	slightly		slightly

5		6
quite	very	extremely discourteous

(Note, that in the example nations 2 and 3 are rated equally, while nations 1, 4, 5, and 6 are rated non-equally. In the example, numbers were used for the nations; in your answers, you will *use the first letter of the nation's name*: A, E, I, O, U, Y, and Z.

1. Indicate the *friendliness to your nation* of the other six nations.

extremely friendly	very	quite	slightly	

slightly	quite	very	extremely unfriendly

2. Indicate the likelihood of each of the other six nations becoming involved in a war with your nation.

extremely likely	very	quite	slightly	

slightly	quite	very	extremely unlikely

3. Indicate the *trustworthiness* of the other six nations in their dealings with your nation.

extremely trustworthy	very	quite	slightly	

slightly	quite	very	extremely untrustworthy

4. Indicate the *helpfulness to your nation* of the other six nations.

extremely helpful	very	quite	slightly	

slightly	quite	very	extremely harmful

5. Indicate the degree of cooperation or conflict which the other six nations show toward your nation.

extremely cooperative	very	quite	slightly	

slightly	quite	very	extremely conflicting

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